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*EDUCATIONAL VALUES.**

HISTORY is always an attractive subject because it appeals to our sympathies. There is not one of us who has not been spurred to effort by the hope of reward, intellectual, moral, social, or material. Every one has at times enjoyed the consciousness of success, or suffered the sting of failure. The history of the race is the collective history of individuals. Every individual can in imagination put himself into the place of the actors who have left strong impressions on the world and been enrolled among the makers of history.

The history of education appeals less strongly to our feelings than does the recital of deeds that determined or destroyed men's leadership in the control of their fellows. But all of us have a very real interest in some of the educational problems of the day. From some points of view it is fortunate, from others, unfortunate, that the consideration of these problems implies conflict. We have all heard about a conflict, which is said to be very sanguinary, between the advocates of scientific study and those of liberal culture. I must confess that in my earliest manhood I rushed into this affray with all the joy and enthusiasm and self-confidence that a young man feels when he knows that he must be inflicting hard blows upon the adversary,

*An address before the student body of Washington and Lee University, February 14, 1900.

even if the adversary does not think them very hard. I had spent several years in mastering a certain amount of Latin, Greek, mathematics and a few other subjects of supposed minor importance. In regard to educational values my opinions were soon very decided; and the decision was by no means in favor of the curriculum through which I had been guided by my respected but mistaken friends, the professors. It is a familiar saying that "history repeats itself." Having stepped some years ago out of the young man's shoes into those of the professor, I am now at liberty to wonder how many students will go forth from this institution next summer, ready to prove that not only I myself, but all of my esteemed friends, my colleagues in this faculty, are old fogies.

The world cannot get along without young men. Perhaps it could, but it does not, get along without the old fogies. We have all heard of the man who was born tired. I have actually seen a good many men who were born old fogies, and who became superannuated before reaching middle age. I have seen others who had passed their three score years and ten without losing the passion for progress, the willingness to take in new ideas, the intellectual alertness of their youth. But certain it is that most of us need contact with young men to keep us from becoming too self-satisfied. The college professor has other duties besides pouring out knowledge and testing his students by written examinations. He must be tested by them; he must let them see that the reciprocity is not all on one side. As soon as he begins to think that he has nothing to learn from them, it becomes the proper time for him to step aside. They are his teachers so long as he retains the capacity to learn. They may make mistakes; but so does he. They are generally disposed to be progressive, if their independence has not been stifled by too great success in acquiring the habit of depending upon authority. If there is any one characteristic by which the scientific education of to-day is conspicuously in contrast with the so-called liberal education of two generations ago, it is found in the modern inculcation of the duty to be independent and manly, to use authorities as means and not as ends, and to accept no authority whatever as beyond question.

Let us go back for a moment then into ancient history and inquire into the origin of the worship which some of us were taught to offer to the fair goddess of liberal culture, the worship of a name while the actual culture was anything but liberal. It is not my wish to criticise our own conditions here; for happily the Washington and Lee University of to-day is so different from the Washington College of our grandfathers that they would find themselves much puzzled, perhaps even shocked, if they could step forth from their graves and visit us. The idea with which they were saturated was that the chief end of all education was discipline, and that a certain small number of subjects were inherently better for discipline than all else that related to human interests. If the young man were drilled until he could memorize a Greek play, a Latin oration, and a chapter of calculus, he was conventionally the possessor of liberal culture. The allowance was, as we now believe, very illiberal; but it was all that he could get. There were three liberal professions, divinity, law, and medicine, one of which he must select, but not one of which involved any special application of what he had studied in college. Vicarious discipline was, therefore, the sacred means by which he was to attain his earthly salvation.

Such an idea of education was accepted quite generally and cheerfully, because it was traditional and therefore respectable. It had been usual not only during the pre-

vious generation but during a hundred generations. Among the ancient Greeks the body was educated by gymnastic exercises, but this was confined chiefly to the aristocracy; for useful labor, involving bodily exercise and hence muscular development, was looked upon as menial and degrading. Intellectual education was regarded from the same standpoint. It might be a badge of gentility, but to seek useful knowledge was no more an educational object than to learn useful arts. Intellectual gymnastics for its own sake was a source of pleasure. To regard it as a source of profit would be to degrade it. "Not the game, but the excitement of the chase; not the truth, but the exhilaration of its pursuit, were the mottoes of culture. Under these circumstances no vulgar question of economy could arise; mental power was ostentatiously wasted, and with the necessary consequences,—truth unsought was not found; the ends of culture being ignored, there was neither conquest of nature nor progress of society."

Such ideals have continued potent to the present day. In mediæval times they were cultivated in the monasteries. It was for the support of them that universities gradually became organized. They are still dominant at Oxford and Cambridge in England, and in the universities of Germany, France and Italy. Their great value is readily conceded. If they constituted all that could be included in modern education, they would still be worth preserving and fostering. Under such ideals were educated some of the greatest men whose labors have advanced physical science, such as Newton, Huyghens and Laplace. The craving of humanity for intellectual exercise without reference to bread winning is as natural as the craving for food, or bodily activity, or companionship, the love of home, of family, or of country. The love of literature, of art, of science for its own sake, is conspicuously worthy of all commendation and encouragement. To know the best that has been thought and spoken and written, to appreciate the noblest and purest that the painter's brush has left upon canvas, to be capable of taking in the ideas and complex emotions that are conveyed in song and symphony, to apprehend the order and harmony that pervades a universe that is continually undergoing evolution in accordance with law—these are objects well worthy of our best efforts, irrespective of the remuneration that can be expressed in money or material power.

But the culture so eminently worthy of our seeking is not all that the world is justified in holding to be valuable. Why should such training be given in youth? It is not merely because the young are non-producers in society, but because they are more capable of modification than after maturity is reached. That the education to be given in youth should be a preparation for manhood is an idea that does not seem to have been well grasped by the educators in ancient or even comparatively recent times. Education was long reserved for the priesthood, rather than for the manhood of the people. Its underlying idea was the preservation of scholastic authority rather than the development of intellectual independence and moral power. It was intended to be a luxury for the few, while the masses were expected to keep on toiling in ignorance as had been done throughout untold centuries. The education of the English universities, even of this year 1900, is essentially aristocratic. Great stress is laid upon certain subjects, not because they afford the best culture, but because they are traditionally genteel, not because they confer power, but because they have long been fostered by the nobility. Even the army, officered by aristocrats who substituted gentility for military knowledge, has been this winter betraying its organic weak-

ness in South Africa; and the liberally educated English have yet (February 14, 1900) to herald their first victory over the despised Boers, after four months of disastrous grappling. They will in time be victorious, but not by the application of what they have been taught through genteel traditions.

The educational system of a country should be adjusted to the needs of the majority of its people, and not be controlled by the nobility, whether this term be applied to the aristocracy of inherited rank, as in England, or of wealth, as in America. As soon as the question of educational values arises, therefore, we must ask ourselves, with candor and with utter disregard of genteel traditions, what kinds of knowledge are best fitted to develop mental, moral, and material power in our young men, recognizing the conditions of civilization as they exist to-day in the most prosperous parts of America. We are not to decry liberal culture; but we are abundantly justified in criticising the traditional limitations which have restricted the name of liberal culture quite arbitrarily to a certain group of studies. What is the ground upon which these studies have been called liberal? It is that they are now, and have long been, genteel; that they do not aim to help their votaries to make money; that their object is to produce such intellectual and social polish as money can not buy; that the stored-up capital which they represent must not yield interest in money, but only in culture; it must be totally independent of all commercial values.

This ideal was almost completely fulfilled during the many centuries of its dominance up to the nineteenth century. But commerce is stronger than an ideal. Is literary culture to-day without its pecuniary rewards? Is fine art practiced purely for the purpose of expressing the beautiful? So far as activity is expended for the cultivation of the true, the beautiful, and the good, the culture is liberal. So soon as the results of such activity cease to be given freely to the world, and become devoted to the acquisition of money, the name liberal ceases to be applicable. There are hundreds of men and women whose interests in college were concentrated upon literature, classics and history, and who apply the results of the mental discipline thus acquired, and the knowledge thus stored up, directly to the money-making business of writing novels. There are thousands more who are well paid for contributing to the newspapers such fiction as is euphemistically called news. All of it is called literary work, and the writers receive the credit of dwelling in an atmosphere of liberal culture. Fortunes have been made by judicious response to the popular demand for light literature, and the liberal culture disseminated is directly proportional to the liberal payment laid down in silver and gold. On the other hand there is an increasing number of young men who annually come forth from American universities, and yet more from German universities, whose time has been devoted to studies that by contrast are called scientific. They spend time and labor in the pursuit of science for its own sake. The results of their investigations are published in journals for which the general public has no use; and they receive no compensation for such contributions except the satisfaction of making themselves and their work known to the so-called scientific world. Their inquiries relate to subjects which have no commercial importance, and their object is without pay to enlarge the boundaries of human knowledge. Their stimulus is the pleasure of discovery, of investigation, of successful intellectual activity. The recognition they receive is such as money cannot possibly buy.

Nor have these scientific investigators been confined to the present century. New-

ton's Principia marked an epoch in science. It brought no money to its author, though succeeding generations have built upon it the remunerative science of navigation. Huyghens, Young, and Fresnel established the wave theory of light, the foundation of the now useful science of optics. They gave the products of their labor freely to the world, living economically, and dying with very small possessions. Gauss and Weber established the modern science of magnetism, while Volta, Oerstedt, Ampere, Ohm, Faraday, Henry, and Maxwell worked together and in succession to make electricity an exact science. They received no pecuniary rewards, but we to-day are reaping the fruits of their labors in the electrical industries that afford employment to a million of men and absorb hundreds of millions of capital. Shall we declare that these original investigators, these men of genius, were not representatives of liberal culture, merely because the subjects upon which their brain power was expended happened not to relate to literature, or linguistics, or art, or history? Some of these much decried scientific men, such as Tyndall, Huxley, and Darwin proved themselves to be adepts in the art of writing clear and forcible English. Were they devoid of culture? Tyndall knew little of Latin and nothing of Greek, but in the battle where tradition was arrayed against truth he displayed such culture and such vigor as to make him a match for more than one classically educated bishop.

The attempt to establish a line of division between science and liberal culture is an anachronism. We have outgrown the authority of our fathers who accepted the exclusive gentility of a certain group of studies and shrugged their shoulders at the young parvenue whom they called science. Let me here express my sympathy with the protest directed against the abuse of this comprehensive word, science. If the meaning of a word is determined by etymology, science merely means knowledge. It makes no difference whether the subject be chemistry, physics, economics, or philosophy; if the knowledge be definite, consistent and organized, it is science. If it be vague, if mere fancy is accepted as a substitute for fact, if dogma is balanced against demonstration, it is not science, it is not knowledge, though it may be brilliant imagination. But the meanings popularly attached to words are not determined by etymology. Whether rightly or wrongly, the word science has become restricted by tacit popular agreement to our knowledge of things in contrast with our knowledge of words or our speculations about ideals. When we appeal to nature our conclusions need verification before final acceptance. Those methods of investigation which imply verification are conventionally called scientific. If they become successfully applied to any subject whatever, the knowledge thus acquired becomes scientific.

Thanks to the scientific spirit that has leavened all modern institutions of learning, the scientific method is now increasingly applied to subjects which were formerly bound down by the shackles of tradition. It has raised to a high and dignified level subjects which were not recognized a generation ago as having any place in a liberal education. Prominent among these new sciences, these new elements of liberal culture, are political science and economics, equal in importance with physics and chemistry, even if they do not call for laboratory work. These new sister sciences may not be so traditionally genteel as the prim old sisters called classics and mathematics, but they are fresh, smiling and apparently quite irresistible.

The extent to which the old and traditional culture studies are giving place to modern and equally liberal culture studies is well shown by reference to last year's

statistics at Yale University, an institution which was long one of the strongholds of conservatism. In all the higher educational institutions of the present day more or less liberty is accorded the student to elect at least some of the studies to which his time is to be devoted. The most popular subject at Yale last year was political economy, which was elected by 957 students. History was elected by 822, English by 529, philosophy by 398, modern languages by 266, classics, including both Latin and Greek by 172, and mathematics by 37. Under the head of natural science, including astronomy, physics, chemistry, geology and biology, the number of elections was 257. This certainly does not look as if the representatives of science, using this term in its conventional sense, are in a position to smile, either contemptuously or patronizingly, upon the devotees to so-called liberal culture.

The object of education is to make each one of us as nearly perfect a human being as he is capable of becoming. The great majority of those who begin to receive an education are restricted to elementary work. The determination of educational values depends in every case upon individual needs. Good mental discipline can be acquired by the systematic and earnest study of any subject whatever if the student has a living conviction of its importance, and the teacher has brains, enthusiasm, and skill. Any subject may be made a means of liberal culture if both teacher and student are stimulated by the love of knowledge. The law school, the medical school, the technological school are as necessary for the higher grades of professional culture as the college is for general culture. The student is not harmed but healthfully stimulated by his recognition of the vital importance to himself of what is drawing forth his best efforts. Let us welcome every new opportunity that is given our young men to adapt themselves to the requirements of modern life. No amount of declamation or invective can displace physical science from its present high position. Those of us who are devoted to science are willing and glad to clasp hands with all who are ready to go with us onward and upward.

No classification of educational values has been given that is superior to that that was expressed about forty years ago by one of the greatest of modern thinkers, Herbert Spencer. In the order of their relative importance the leading kinds of activity which constitute human life are grouped as follows:

1. Those which directly minister to self-preservation.

2. Those which, by securing the necessaries of life, indirectly minister to self-preservation.

3. Those which have for their object the rearing and training of the young.

4. Those which are involved in the maintenance of proper social and political relations.

5. Those which make up the leisure part of life, devoted to the gratification of the tastes and feelings.

The best education is the best preparation for all of these activities, its aim being to maintain a due proportion between the degrees of preparation in each. The order of relative importance is obviously the inverse of the order of diversity and complexity. It is not surprising therefore that up to a very recent time the work of educators has been confined chiefly to the last one of the groups of activities enumerated by Spencer. But in spite of educational traditions the world has lately been demanding attention to the other groups, and modern science as taught in our foremost universities and technical schools is the response to that demand. Mr. Spencer considers the educational needs implied for the best exer-

cise of all these activities; and in answer to the question—What knowledge is most worth?—the answer is Science.

"For direct self-preservation, or the maintenance of life and health, the all important knowledge is—science. For that indirect self-preservation which we call gaining a livelihood, the knowledge of greatest value is—science. For the due discharge of parental functions, the proper guidance is to be found only in—science. For that interpretation of national life, past and present, without which the citizen cannot rightly regulate his conduct, the indispensable key is—science."—economics and political science. "For the most perfect production and highest enjoyment of art in all its forms the needful preparation is still—science. And for purposes of discipline, intellectual, moral, religious, the most efficient study is still—science."

It is not to be expected that these conclusions will be accepted by all to whom they are addressed. I should be the last to decry the importance of language study, of history, art, and philosophy. I emphatically emphasize the importance of national education in economics and political science. We are sadly in need of better political teachers than a majority of those who during the last few years have been the leaders in American politics. But I protest against the implication that liberal culture is suffering at the hands of either the active workers or the leading teachers in science. So long as human needs and human tastes are diversified must there be corresponding diversity in education. Let each of us recognize what is good in our neighbor, let us cheerfully and cordially acknowledge the value of his contribution to human welfare. Let us remember that there are others besides scientific men who are progressive, and that the boundaries of knowledge are without limit.

Within the present century one of the greatest mathematicians and astronomers that the world has ever known, Laplace, lay on his dying bed in Paris. His last words were: "Ce que nous savons est peu de choses; ce que nous ignorons est immense." It takes a philosopher to recognize the immensity of his own ignorance. If Laplace could use those words as he fell asleep, why can we not at least follow him and remain at peace with each other while striving to do our share in increasing human knowledge? Linguist and engineer, historian and chemist, economist and physicist, metaphysician and mathematician, our aims radiate from a common center; but friendly and faithful as we may be to each other, our ignorance will still continue to be immense.

W. LE CONTE STEVENS.

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*PICTURES PRODUCED ON PHOTOGRAPHIC PLATES IN THE DARK.**

I THINK I may fairly assume that every one in this theater has had his photograph taken, and consequently must have some idea of the nature of the process employed. I have, therefore, only to add, with regard to what is not visible in the process of taking the picture, that the photographic plate is a piece of glass or such like body, coated on one side by an adhesive paste which is acted on by light, and acted on in a very remarkable manner. No visible change is produced, and the picture might remain latent for years, but place this acted-on plate in a solution, of, say pyrogallol, and the picture appears. The subsequent treatment of the plate with sodium hyposulphite is for another purpose, simply to prevent the continuance of the action when the plate is brought into the light. Now, what I purpose demonstrating to you to-night is that there are other ways of producing pictures on photographic plates than by acting on them by light, and that by these other

* Address before the Royal Institution of Great Britain.

means a latent picture is formed, which is rendered visible in precisely the same way as the light pictures are.

The substances which produce on a photographic plate these results so strongly resembling those produced by light, are, some of them, metallic, while others are of vegetable origin. At first it seemed very remarkable that bodies so different in character should act in the same way on the photographic plate. The following metals—magnesium, cadmium, zinc, nickel, aluminium, lead, bismuth, tin, cobalt, antimony—are all capable of acting on a photographic plate. Magnesium most strongly, antimony but feebly, and other metals can also act in the same way, but only to a very slight extent. The action in general is much slower than that of light, but under favorable conditions a picture may be produced in two or three seconds.

Zinc is nearly as active as magnesium or cadmium, and is the most convenient metal to experiment with. In its ordinary dull state it is without the power of acting on a photographic plate, but scratch it or scrape it, and it is easy to prove that the bright metal is active. I would say that all the pictures which I have to show you, by means of the lantern, are produced by the direct action of the metal, or whatever the active body may be, on the photographic plate, and that they have not been intensified or touched up in any way. This first slide is the picture given by a piece of ordinary zinc which has been rubbed with some coarse sand-paper, and you see the picture of every scratch. Here is a piece of dull zinc on which some circles have been turned. It was exposed to the photographic plate for four hours at a temperature of 55°C. In the other cases, which are on a larger scale, a zinc stencil was polished and laid upon a photographic plate, and you see where the zinc was in contact with the plate much action has occurred. In another case a bright zinc plate was used, and a Japanese stencil interposed between it and the photographic plate, and a very strong and sharp picture is the result. The time required to produce these zinc pictures varies very much with the temperature. At ordinary temperature the exposure would have to be for about two days, but if the temperature was, say, 55°C., then half to three-quarters of an hour might be sufficient. Temperatures higher than this cannot be used except for very short times, as the photographic plate would be damaged. Contact between the zinc and photographic plate is not necessary, as the action readily takes place through considerable distances. Obviously, however, as you increase the distance between object and plate, so you decrease the sharpness of the picture, as is shown by the following pictures, which were taken respectively at a distance of 1 mm. and 3 mm. from the scratched zinc surface. The appearance of the surfaces of different metals varies, and the following slides show the surface of a plate of bismuth, a plate of lead and one of aluminium. On the next slide are the pictures produced by similar pieces of pure nickel and cobalt, and it clearly shows how much more active in this way nickel is than cobalt. Many alloys, such as pewter, fusible metal, brass, etc., are active bodies, and in the case of brass the amount of action which occurs is determined by the amount of zinc present. Thus you will see that a brass with 30 per cent. of zinc produces hardly any action on the photographic plate, but when 50 per cent. of zinc is present there is a fairly dark picture, and when as much as 70 per cent. is present a still darker picture is produced.

The second class of bodies which act in the same way on a photographic plate are organic substances, and belong essentially to the groups of bodies known as terpenes. In trying to stop the action of metallic zinc, which I thought at the time

might arise from vapor given off by the metal, copal varnish was used, but in place of stopping the action it was found to increase it, and this increase of activity was traced to the turpentine contained in the varnish. In experimenting with liquids it is convenient to use small shallow circular glass vessels such as are made for bacteriological experiments, the plate resting on top of the vessel, and the amount of liquid in the vessel determining the distance through which the action shall take place. The following slide, produced in this way, shows how dark a picture ordinary turpentine produces. All the turpenes are active bodies. Dipentine is remarkably so; in a very short time it gives a black picture, and if the action be continued, the dark picture passes away, and you then have a phenomenon corresponding to what photographers call reversal. The strong smelling bodies known as essential oils, such as oil of bergamot, oil of lavender, oil of peppermint, oil of lemons, etc., are all active bodies, and all are known to contain in varying quantities different terpenes; therefore ordinary scents are active bodies, and this is shown by the following pictures produced by eau de Cologne, by cinnamon, by coffee, and by tea. Certain wines also act in the same way: Sauterne gives a tolerably dark picture, but brandy only a faint one. Other oils than these essential ones are also active bodies: linseed oil is especially so; olive oil is active, but not nearly as much so as linseed oil; and mineral oils, such as paraffine oil, are without action on the photographic plate.

Interesting results are obtained with bodies which contain some of these active substances; for instance, wood will give its own picture, as is shown by the following slides: the first is a section of a young spruce tree, the next a piece of ordinary deal, and the third of an old piece of mahogany. Again, the next slide you will recognize as the picture of a peacock's feather. There is much interest in these pictures of feathers, as they distinguish the brilliant interference colors from those produced by certain pigments; the beautiful blue in the eye of the peacock's feather is without action on the photographic plate. Butterflies' wings, at least some of them, will draw, as you see, their own pictures. Linseed oil, which is a constituent of all printing ink, makes it an active body, and it can, like the zinc and other active bodies, act through considerable distances. In the picture before you the ink was at a distance of one inch from the plate, and the next slide shows what a remarkably clear and dark picture ordinary printing can produce. As the composition of printing ink varies so does its activity, and here are pieces of three different newspapers which have acted under the same conditions on the same plate, and you see how different the pictures are in intensity. Printed pictures, of course, act in the same way—here is a likeness of Sir H. Tate taken from 'The Year's Art.' The pictures and printing in *Punch* always print well; so does the yellow ticket for the Friday evening lectures at the Royal Institution; also the rude trade-mark on Wills's tobacco, and it is of interest because the red pigment produces a very clear picture, but the blue printing is without action on the plate.

An interesting and important peculiarity of all these actions is that it is able to pass through certain media; for instance, through a thin sheet of gelatin. Here are two plates of zinc; both have been scratched by sand-paper; one is laid directly on the photographic plate, and the other one has a sheet of gelatin, its color is of no note, laid between it and the sensitive plate; the picture in this case is, of course, not so sharp as when no gelatin is present, but it is a good and clear likeness of the scratches.

Celluloid is also a body which allows the

action to pass through it, as is seen in this picture of a piece of perforated zinc, a picture which was produced at ordinary temperatures. Gold-beaters' skin, albumen, collodion, gutta-percha, are also bodies which are transparent to the action of the zinc and the other active bodies. On the other hand, many bodies do not allow the transmission of the action through them; for instance paraffin does not, and among common substances writing-ink does not, as is easily shown by placing ordinary paper with writing on it between the active body and the photographic plate. The active body may conveniently be either a plate of zinc or a card painted with copal varnish and allowed to dry, or a dish of drying oil. The picture of an ordinarily directed envelope shows this opacity of ink well. It is a property long retained by the ink, as this picture of the direction of a letter, written in 1801, shows; also this letter of Dr. Priestley's, dated 1795; and here is also some very faded writing of 1810, which still gives a very good and clear picture. Even if the writing be on parchment, the action passes through the parchment, but not through the ink, and hence a picture is formed.

With bodies which are porous, such as most papers, for instance, the action passes gradually through the interstices, and impresses the plate with a picture of the general structure of the intervening substance. For instance, the following pictures show the structure and the water-mark of certain old and modern writing-papers. Some modern writing-papers are, however, quite opaque; but usually paper allows the action to take place through it, and combining this fact with the fact of strong activity of the printing-ink, the apparently confused appearance produced on obtaining a picture from paper with printing on both sides is accounted for, as the printing on the side away from the photographic plate, as well as that next to it, prints through the paper, and is, of course, reversed.

I hope I have now given you a clear idea how a picture can be produced on a photographic plate in the dark, and the general character and appearance of such pictures. I now pass on to the important question of how they are produced. Moser suggested fifty years ago that there was 'dark light,' which gave rise to pictures on polished metallic plates, and lately it was suggested that pictures were produced by vapor given off by the metals themselves; the explanation, however, which I have to offer you is, I think, simpler than either of these views, for I believe that the action on the photographic plate is due to the formation of a well-known chemical compound, hydrogen peroxide, which undergoing decomposition acts upon the plate and is the immediate cause of the pictures formed. The complicated changes which take place on the sensitive plate I have nothing to say about on the present occasion, but I desire to convince you, that this body, hydrogen peroxide, is the direct cause of these pictures produced in the dark. Indirect proof has to be resorted to. Water cannot be entirely excluded, for an absolutely dry photographic plate would probably be perfectly inactive, and as long as water is present peroxide of hydrogen may be there also. But what are the conditions under which these pictures are formed? Only certain metals are capable of producing them. This list of active metals which I have mentioned to you was determined solely by experiment, and when completed it was not evident what common property bound them together. Now, however, the explanation has come for these are the very metals which most readily cause, when exposed to air and moisture, the formation of this body peroxide of hydrogen. Schönbein showed as long ago as 1860 that when zinc turnings were shaken up in a bottle with a

little water hydrogen peroxide was formed, and the delicate tests which we now know for this body show that all the metals I named to you not only can in the presence of moisture produce it, but that their power of doing so follows the same order as their power of acting on a photographic plate. Again, what happened with regard to the organic bodies which act on the photographic plates? I have already mentioned that in experimenting with the metals it was accidentally observed that copal varnish was an active substance producing a picture like that produced by zinc, and that the action was traced to the turpentine present; again a process very much like groping in the dark had to be carried on in order to determine which were active and which inactive organic bodies, and the result obtained was that the active substances essentially belonged to the class of bodies known to chemists as terpenes. Now a most characteristic property of this class of bodies is that in presence of moisture and air they cause the formation of hydrogen peroxide, so that whether a metal or an organic body be used to produce a picture, it is in both cases a body capable, under the circumstances, of causing the formation of hydrogen peroxide. Passing now to experimental facts, which confirm this view of the action on sensitive plates, I may at once say that every result obtained by a metal or by an organic body can be exactly imitated by using the peroxide itself. It is a body now made in considerable quantity, and sold in solution in water. Even when in a very dilute condition it is extremely active. One part of the peroxide diluted with a million parts of water is capable of giving a picture. It can, of course, be used in the glass dishes like any other liquid, but it is often convenient not to have so much water present; and then it is best to take white blotting paper, wet it in the solution of the peroxide, and let it dry in the air. The paper remains active for about twenty-four hours; or, what is still better, take ordinary plaster of Paris, wet it with the peroxide solution, and let it set 'in a mould' so as to get a slab of it. This slab increases in activity for the first day or two after making, and retains its activity for a fortnight or more. Such a slab will give a good and dark picture in three or four seconds.

To show how similar the pictures produced by the peroxide and those by zinc are, pictures of a Japanese paper stencil, which had been paraffined to make it quite opaque, have been made by both processes, and are shown with other instances in which turpentine was used in the following slides. It is also very easy to obtain good pictures with the peroxide alone of the structure of paper, etc.; see, for instance, this one of a five-pound note and these of lace. Again, the strict similarity between the action of the peroxide and that of the metals and organic bodies is further shown by the fact that its action passes through the same media as their action does; and here are good pictures formed by the action of the peroxide after passing through a sheet of these substances. How this singular transmission can be explained, I have treated of elsewhere, and time does not allow of my discussing the matter to-night.

There are many ways in which the bright, active zinc surface can be modified. Draw your finger across it, press your thumb upon it, and you stop its activity, as is shown by the picture it will give. Lay a printed paper on the zinc, and let the contact continue for three-quarters of an hour, at a temperature of 55°, then bring the zinc in contact with a sensitive plate, a picture of the printing is formed, but allow the contact between the zinc and printing to continue for eighteen hours at the same temperature, and the picture then given by the zinc is the reverse of the former one.

Where the ink has been is now less active than the rest of the plate. Here are slides which show these positive and negative pictures. Another way of modifying the zinc surface is interesting. You have seen that the ordinary zinc surface which has been exposed to air and moisture is quite inactive, but if a bright piece of zinc be immersed in water for about twelve hours, the surface is acted on; oxide of zinc is formed, showing generally a curious pattern. Now if the plate be dried, it will be found that this oxide is strongly active, and gives a good picture of the markings on the zinc. The oxide evidently holds, feebly combined or entangled in it, a considerable quantity of the hydrogen peroxide, and it requires long drying or heating to a higher temperature to get rid of it. Also, if a zinc plate be attacked by the hydrogen peroxide, the attacked parts become more active than the bright metal. Thus place a stencil on a piece of bright zinc, and expose the plate to the action of an active plaster of Paris slab, or to active blotting-paper for a short time, then, on removing the stencil, the zinc plate will give a very good picture of the stencil. Any inactive body—for instance, a piece of Bristol board or any ordinary soft paper—can be made active by exposing it above a solution of peroxide, or, more slowly, by exposing it to a bright zinc surface. If, for instance, a copper stencil be laid on a piece of Bristol board, and a slab of active plaster of Paris be placed on the stencil for a short time, the Bristol board will even, after it has been removed from the stencil for some time, give a good picture of the stencil. Drying oil and other organic bodies may be used in the same way to change the paper. A curious case of this occurred in printing a colored advertisement cut out of a magazine, for there appeared printing in the picture which was not in the original. This printing was ultimately traced to an advertisement on the opposite page, which had been in contact with the one which was used; thus this ghostly effect was produced.

I believe, then, that it is this active body, hydrogen peroxide, which enables us to produce pictures on a photographic plate in the dark. There are many other curious and interesting effects which it can produce, and which I should like to have shown you, had time permitted.

I would only add that this investigation has been carried on in the Davy Faraday Laboratory of this Institution.

William James Russell.

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*DEGENERATION IN THE EYES OF THE COLD-BLOODED VERTEBRATES OF THE NORTH AMERICAN CAVES.**

"Degeneration," says Lankester, "may be defined as the gradual change of the structure in which the organism becomes adapted to less varied and less complex conditions of life; whilst elaboration is a gradual change of structure in which the organism becomes adapted to more and more varied and complex conditions of existence."

Degeneration may affect the organism as a whole or some one part. I propose to speak not on degeneration in general but to give a concrete example of the degeneration of the parts of one organ.

The eyes of the blind vertebrates of North America lend themselves to this study admirably because different ones have reached different stages in the process, so by studying them all we get a series of steps through which the most degenerate has passed. This enables us to reach conclusions

* Presidential address at the meeting of the Indiana Academy of Sciences, Dec. 27, 1899. The detailed account of the eyes, whose general features are given here, has in part been published in Roux's Archiv f. Entwickelungsmechanik, VIII., and will in part be published in the Proceedings Am. Microscopical Society for 1899.

that the study of an extreme case of degeneration would not give.

I shall confine myself to the cave salamanders and the blind fishes (Amblyopsidæ) nearly all of which I have visited in their native haunts. The salamanders are introduced to illuminate some dark points in the degeneration of the eyes of the fishes and to emphasize a fact that is forcing itself forward with increasing vehemence, *i. e.*, that cross-country conclusions are not warrantable, that the blind fishes form one group and the salamanders other groups, and that, however much one may help us to understand the other, we must not expect too close an agreement in the steps of their degeneration under similar conditions.

There are three cave salamanders in North America.

1. *Spelerpes maculicauda* is found generally distributed in the caves of the Mississippi valley. It so closely resembles *Spelerpes longicauda* that it has not until more recent years been distinguished from the latter which has an even wider epigæan distribution. There is nothing about the structure of this salamander that marks it as a cave species but its habits are conclusive.

2. *Typhlotriton* is much more restricted in its distribution, being confined to a few caves in southwestern Missouri. I have taken its larvæ at the mouth of Rock House cave in abundance. In the deeper recesses of Marble cave I secured both young and adult. This is a cave species of a more pronounced type. The very habit that accounts for the presence of salamanders in caves has been retained by this one. I found some individuals hiding (?) under rocks and in the aquarium their steriotropic nature manifests itself by the fact that they crawl into glass tubing, rubber tubing or under wire screening. In the eye of this species we have some of the early steps in the process of degeneration.

3. *Typhlomolge* has been taken from a surface well near San Marcos, Texas, and from the artesian well of the U. S. Fish Commission which taps a cave stream about 190 feet from the surface. It has also been seen in the underground stream in Ezel's cave near San Marcos. It was also reported to me from south of San Antonio, Texas. This is distinctly and exclusively a cave species and its eyes are more degenerate than those of any other salamander, including the European Proteus.*

The Amblyopsidæ are a small family of fresh water fishes and offer exceptional facilities for the study of the steps in the degeneration of eyes. There are at least six species and we have gradations in habits from permanent epigæan species to species that have for ages been established in caves.

The species of *Chologaster* possess well developed eyes. One of them, *C. cornutus*, is found in the coast streams of the southeastern States; another, *C. papilliferus*, is found in some springs in southwestern Illinois, while the third, *C. agassizii* lives in the cave streams of Kentucky and Tennessee.

The other members of the family are cave species with very degenerate eyes. They represent three genera which are descended from three epigæan species. *Amblyopsis*, the giant of the race, which reaches 135

*It may be noticed that the eyes of the western *Typhlotriton* are more degenerate than those of the cave *Spelerpes* of wider distribution. Further the eyes of the Texan *Typhlomolge* are more degenerate than those of the Missouri *Typhlotriton*. Now similarly the Missouri blind fish *Troglichthys* has eyes in a much more advanced state of degeneration than the Ohio valley blind fishes. It is possible that the explanation is to be found in the length of time the caves in these regions have been habitable. During the glacial epoch the caves of the Ohio valley were at or near the northern limit of vegetation. The Missouri caves, if affected by glaciation, must have become habitable before those of the Ohio valley, while those of Texas were probably not affected at all.

mm. in length, is found in the caves of the Ohio Valley. *Typhlichthys* is also found in the Ohio Valley but chiefly south of the Ohio river. But a single specimen has been found north of the Ohio and this represents a distinct species. *Troglichthys* which is found in the caves of Missouri, has been in caves longer than its relatives if the degree of degeneration of its eyes is a criterion.

Before dealing with the degeneration of the eye a few words are in order on the normal structure of the organ under consideration.

In the normally developed eye we may distinguish a variety of parts with different functions. These are:

A. Organs for protection like the lid and orbits.

B. Organs for moving the eye to enable it to receive direct rays of light. In the cold-blooded vertebrates these consist of four rectus muscles and two oblique.

C. Organs to support the active structures, the fibrous or cartilaginous sclera.

D. The eye itself consisting of:

1. Parts for transmitting and focusing light; the cornea, lens and vitreous body.

2. Parts for receiving light and transforming it to be transmitted to the brain; the retina.

3. A part for transmitting the converted impression to the brain; the optic nerve.

Some of these as the muscles, retina and optic nerve are active while others, the protective and supporting organs, are passive.

A. In the Amblyopsidæ the skin passes directly over the eye without forming a free orbital rim or lid. The skin over the eye in *Chologaster* is much thinner than elsewhere and free from pigment. In the other species of the family the eye has been withdrawn from the surface. In these it lies deep beneath the skin and the latter where it passes over the eye, has assumed the structure normal to it in other parts of the head.

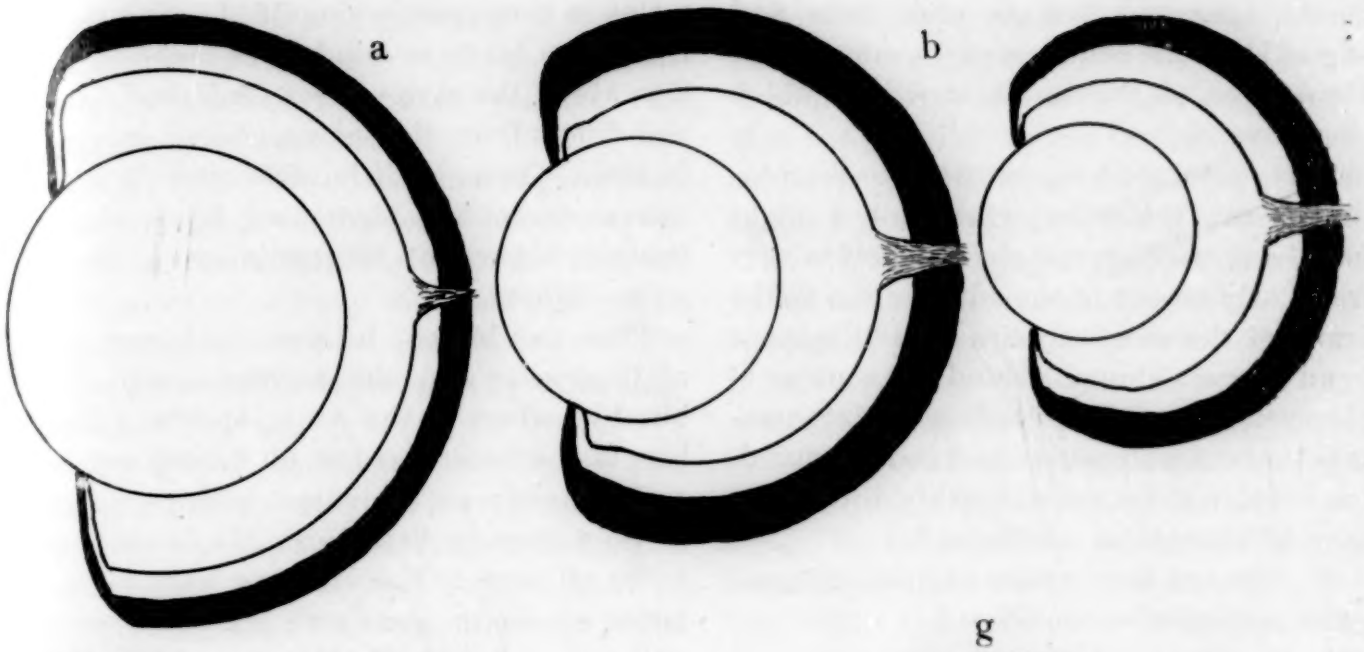
In the salamanders we have a perfect gradation in the matter of the eye-lids. In *Spelerpes* a free orbital rim is present in every respect like that found in epigæan salamanders. In *Typhlotriton* the lids are closing over the eye. The slit between the upper and lower lid is much shorter than normally and the upper lid overlaps the lower. The conjunctiva is still normal. The eye of this species is midway between the normal salamander eye and that of *Typhlomolge*, in which a slight thinning of the skin is all there is to indicate its former modification over the eye.

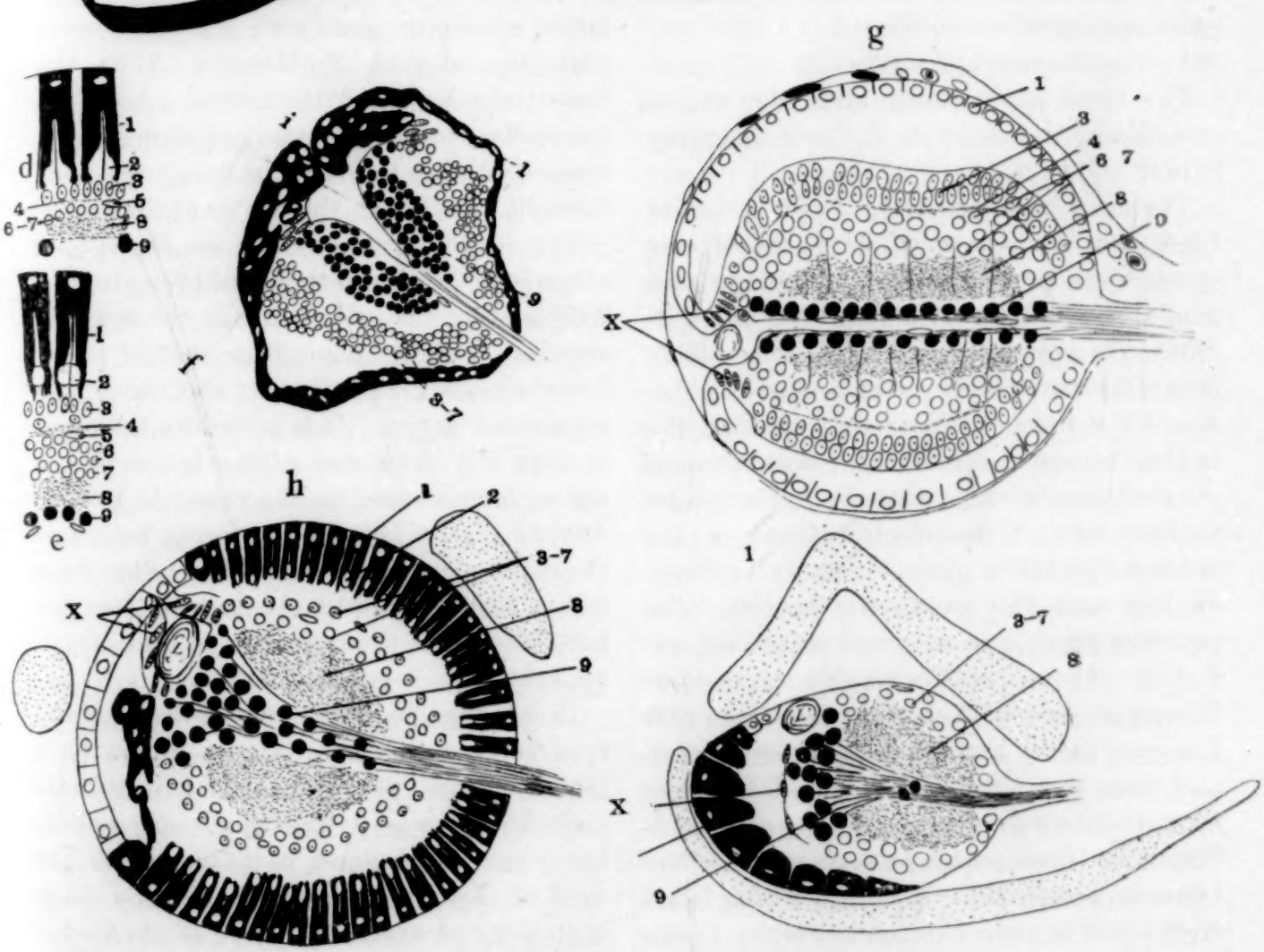
B. The muscles to change the direction of the eye-ball show complete gradations from perfect development to total disappearance.

In the species of *Chologaster* all the muscles are normally developed. In *Amblyopsis* the muscles are unequally developed, but one or more are always present and can be traced from their origin to the eye. In *Troglichthys*, the distal halves of the muscles, the parts nearest the eye have been replaced by connective tissue fibers, *i. e.*, a tendon has replaced part of the muscle. Here we have a step in advance in the degeneration found in *Amblyopsis* and no instance was noticed where *all* the muscles of any eye were even developed in the degree described. In *Typhlichthys* the muscles have all disappeared.

In *Typhlomolge* the muscles have disappeared; in the other salamanders they are present.

C. The sclera is differently developed in *Chologaster*, and there is but little modification in the species with more degenerate eyes except that in *Amblyopsis* and *Troglichthys*, where cartilaginous bands were evidently present in the epigæan ancestors. These bands have persisted in a remarkable degree, being much too large for the minute eyes with which they are connected. In *Troglichthys* they form a hood over the front





a to *i*. Diagrams of the eyes of all the species of the Amblyopsidæ and of Typhlomolge.

a to *c* are the eyes of *Chologaster cornutus*, *papilliferus* and *agassizii* drawn to scale.

d, *e*, *g*, *h* and *i* are drawn under the same magnification.

d. The retina of *Chologaster cornutus*.
e. The retina of *Chologaster papilliferus*.
f. The eye of *Typhlomolge* under lower magnification.
g. The eye of *Typhlichthys subterraneus*.
h. The eye of *Amblyopsis spœlus*.
i. The eye of *Troglichthys rosæ*.

of the eye, and various projections and angles in their endeavor to accommodate themselves to the small structure which they cover.

This is in striking contrast to the conditions in *Typhlotriton*, where but a slight nodule of cartilage remains and this is very frequently absent in the adult, while in the larva of the same species a cartilaginous band extends almost around the equator of the eye. The different effect of degeneration in the Amblyopsidæ and the salamanders could not be more forcibly illustrated than by the scleral cartilages.*

D. The eye as a whole and its different parts may now be considered.

1. The dioptric apparatus.

The steps in degeneration of the eye in general are indicated in the accompanying figure.

The most highly developed eye is that of *Chologaster papilliferus*. The parts of this eye are well proportioned, but the eye as a whole is small, measuring less than one millimeter in a specimen 55 mm. long. The proportions of this eye are symmetrically reduced if it has been derived from a fish eye of the average size, but the retina is much simpler than in such related pelagic species as *Zygonectes*. The simplifications in the retina have taken place between the outer nuclear and the ganglionic layers. The pigment layer has not been materially affected. These facts are exactly opposed to the supposition of Kohl that the retina and the optic nerve are the last to be affected and that the vitreous body and the lens cease to develop early. In *Chologaster papilliferus* the latter parts are normal, while the retina is simplified. That the retina is affected first is proved beyond cavil by *Chologaster cornutus*. The vitreous body and the lens are here larger than *papilliferus*, but the retina is very greatly simplified. *Cornutus*, it must be borne in mind, lives in the open. The eye of the cave species *Chologaster agassizii* differs from that of *papilliferus* largely in size. There is little difference in the retinas except the pigmented layer, which is about 26 per cent. thinner in *agassizii* than in *papilliferus*.

There is a big gap between the lowest eye of *Chologaster* and the highest eye of the blind members of the Amblyopsidæ. The lens in the latter has lost its fibrous nature and is merely an ill-defined minute clump of cells scarcely distinguishable in the majority of cases. The vitreous body of the latter species is gone with perhaps a trace still remaining in *Typhlichthys*. With the loss of the lens and the vitreous body the eye collapsed so that the ganglionic layer formerly lining the vitreous cavity has been brought together in the center of the eye.

The layers of the retina in *Typhlichthys* are so well developed that could the vitreous body and lens be added to this eye it would stand on a higher plane than that of *Chologaster cornutus*, exclusive of the cones and pigmented layer. It is generally true that at first the thickness of the layers of the retina is increased as the result of the reduction of the lens and vitreous body and the consequent crowding of the cells of the retina whose reduction in number does not keep pace with the reduction in the dioptric apparatus in total darkness.

If we bear in mind that no two of the eyes represented here are members of a phyletic series, we may be permitted to state that from an eye like that of *cornutus*, but possessing scleral cartilages, both the eyes of *Amblyopsis*, and *Troglichthys* have been derived and that the eye of *Amblyopsis* represents one of the stages through which the eye of *Troglichthys* passed. The eye of *Amblyopsis* is the eye of *C. cornutus* minus a vitreous body with the pupil closed and with a minute lens or none at all. The nuclear

* The presence of a cartilaginous band in the young is, possibly, a larval character, and its absence in the adult has, in that case, no bearing on degeneration.

layers have gone a step further in their degeneration than in *cornutus*, but the greatest modification has taken place in the dioptric arrangements.

In *Troglichthys* even the mass of ganglionic cells present in the center of the eye as the result of the collapsing after the removal of the vitreous body has vanished. The pigmented epithelium, and, in fact, all the other layers, are represented by mere fragments.

The eye of *Typhlichthys* has degenerated along a different line. There is an almost total loss of the lens and vitreous body in an eye like that of *papilliferus* without an intervening stage like that of *cornutus*, and the pigment layer has lost its pigment, whereas in *Amblyopsis* it was retained.

The salamanders bridge the gap existing between the *Chologasters* and the blind members of the Amblyopsidæ. But even at the risk of monotonous repetition I want again to call attention to the fact that the salamanders do not belong to the same series as the Amblyopsidæ. The dioptric arrangements of *Typhlotriton* are all normal, the retina is normal in the young, but the rods and cones all disappear with the change from the larval to the adult condition. In *Typhlomolge*, the lens and largely the vitreous body are gone and the eye has collapsed. The vitreous body is, however, much better represented than in the blind Amblyopsidæ and the iris is, especially in the young, much better developed than in the fishes.

2. The retina.

(*a*) There is more variety in the degree of development of the pigment epithelium than in any other structure of the eye. Ritter has found that in *Typhlogobius* this "layer has actually increased in thickness concomitantly with the retardation in the development of the eye, or it is quite possible with the degeneration of this particular part of it. An increase of pigment is an incident to the gradual diminution in functional importance and structural completeness." There is so much variation in the thickness of this layer in various fishes that not much stress can be laid on the absolute or relative thickness of the pigment in any one species as an index of degeneration. While the pigment layer is relative to the rest of the retina, very thick in the species of *Chologaster* it is found that the pigment layer of *Chologaster* is actually not much, if any, thicker than that of *Zygonectes*; exception must be made for specimens of the extreme size in *papilliferus* and *agassizii*. In other words, primarily the pigment layer has retained its normal condition while the rest of the retina has been simplified and there may even be an increase in the thickness of the layer as one of its ontogenic modifications. Whether the greater thickness of the pigment in the old *Chologaster* is due to degeneration or the greater length of the cones in a twilight species, I am unable to say. In *Typhlichthys*, which is undoubtedly derived from a *Chologaster*-like ancestor, no pigment is developed. The layer retains its epithelial nature and remains apparently in its embryonic condition. It may be well to call attention here to the fact that the cones are very sparingly developed, if at all, in this species. In *Amblyopsis*, in which the degeneration of the retina has gone further but in which the cones are still well developed, the pigment layer is very highly developed, but not by any means uniformly so in different individuals. The pigment layer reaches its greatest point of reduction in *rosæ* where pigment is still developed, but the layer is fragmentary except over the distal part of the eye. We thus find a development of pigment with an imperfect layer in one case (*Troglichthys*) and a full developed layer without pigment in another (*Typhlichthys*). In the *Chologasters* the pigment is in part prismatic; in the other species granular.

(*b*) In the outer nuclear layer a complete series of steps is observable from the two-layered condition in *papilliferus* to the one-layered in *cornutus*, to the undefined layer in *Typhlichthys* and the merging of the nuclear in *Amblyopsis*, and their occasional total absence in *Troglichthys*. The rods disappear first, the cones long before their nuclei.

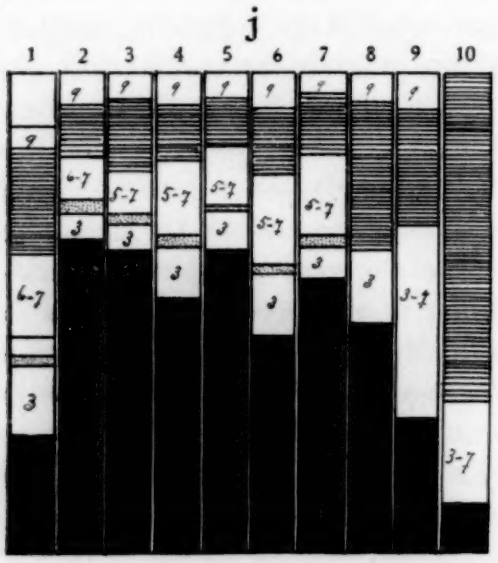


Diagram showing the per cents. of the total thickness of each of the layers of the retina in 1. *Zygonectes notatus*. 2. *Chologaster cornutus* 27 mm. long. 3. 43 mm. long. 4. *Chologaster papilliferus* 29–39 mm. and 5., 55 mm. long. 6. *Chologaster agassizii* 38 mm. long and 7., 62 mm. long. 8. *Amblyopsis*. 9. *Typhlichthys*. 10. *Troglichthys*.

(*c*) The outer reticular layer naturally meets with the same fate as the outer nuclear layer. It is well developed in *papilliferus*, evident in *C. cornutus*, developed in spots in *Typhlichthys*, and no longer distinguishable in other species.

(*d*) The layers of horizontal cells are represented in *papilliferus* by occasional cells; they are rarer in *cornutus* and beyond these have not been detected.

(*e*) The inner nuclear layer of bipolar and spongioblastic cells is well developed in *papilliferus*. In *cornutus* it is better developed in the young than in the older stages where it forms but a single layer of cells. There is evidently in this species an ontogenic simplification. In the remaining species it is, as mentioned above, merged with the outer nuclear layer into one layer which is occasionally absent in *Troglichthys*.

(*f*) The inner reticular layer is relatively better developed than any of the other layers and the conclusion naturally forces itself upon one that it must contain other elements besides fibers of the bipolar and ganglionic cells, for, in *Amblyopsis* and *Troglichthys*, where the latter are very limited or absent, this layer is still well developed. Horizontal cells in this layer have only been found in the species of *Chologaster*.

(*g*) In the ganglionic layer we find again a complete series of steps from the most perfect eye to the condition found in *Troglichthys*. In *papilliferus* the cells form a complete layer one cell deep except where the cells have given way to the optic fiber tracts which pass in among the cells instead of over them. In *cornutus* the cells have been so reduced in number that they are widely separated from each other. With the loss of the vitreous cavity the cells have been brought together again into a continuous layer in *Typhlichthys*, although there are much fewer cells than in *cornutus* even. The next step is the formation of a solid core of ganglionic cells and the final step the elimination of this central core in *Troglichthys*, leaving but a few cells over the anterior face of the retina.

(*h*) Müllerian nuclei are found in all but *Troglichthys*. In *C. cornutus* they lie in part in the inner reticular and the ganglionic layer. Cells of this sort are probably also found among the ganglionic cells of *Typhlichthys*.

3. The optic nerve shows a clear gradation from one end of the series of fishes to the other. In *Chologaster papilliferus* it reaches its maximum development. In *cornutus* which possesses an eye larger than *papilliferus*, but in which the ganglionic

layer is simplified, the nerve is measurably thinner. In *Typhlichthys* the nerve can be traced to the brain in specimens 40 mm. long, *i. e.*, in specimens which are evidently adult. In *Amblyopsis* the nerve can be followed to the brain in specimens 25 mm. long, but in the adult I have never been able to follow it to the brain. In *Troglichthys* it has become so intangible that I have not been able to trace it far beyond the eye.

We thus see that the simplification or reduction in the eye is not a horizontal process. The purely supporting structures like the scleral cartilages have been retained out of all proportion to the rest of the eye. The pigment layer has been both quantitatively and qualitatively differently affected in different species. There was primarily an increase in the thickness of this layer and later a tendency to total loss of pigment. The degeneration has been more uniformly progressive in all the layers within the pigment layer. The only possible exception being the inner recticular layer which probably owes its retention more to its supporting than to its nervous elements. Another exception is found in the cones, but their degree of development is evidently associated with the degree of development of the pigmented layer. As long as the cones are developed the pigmented layer is well developed or *vice versa*.

We find in general then that the reduction in size from the normal fish eye went hand in hand with the simplification of the retina. There was at first chiefly a reduction in the number of many times duplicated parts. Even after the condition in *Chologaster papilliferus* was reached, the degeneration in the histological condition of the elements did not keep pace with the reduction in number (*vide*, the eye of *cornutus*). The dioptric apparatus disappeared rather suddenly and the eye as a consequence, collapsed with equal suddenness in those members which, long ago, took up their abode in total darkness. The eye not only collapsed, but the number of elements decreased very much. The reduction was in the horizontally repeated elements. The vertical complexity, on which the function of the retina really depends, was not greatly modified at first.

In those species which took up their abode in total darkness the degeneration in the dioptric apparatus was out of proportion to the degeneration of the retina, while in those remaining above ground the retinal structures degenerated out of proportion to the changes in the dioptric apparatus, which, according to this view degenerates only under conditions of total disuse or total darkness which would necessitate total disuse. This view is upheld by the conditions found in *Typholgobius*, as Ritter's drawings and my own preparations show. In *Typholgobius* the eye is functional in the young and remains a light perceiving organ throughout life. The fish live under rocks between tide water (Eigenmann, 90). We have here an eye in a condition of partial use and the lens is not affected. The retina has, on the other hand, been horizontally reduced much more than in the Amblyopsidæ, so that should the lens disappear, and Ritter found one specimen in which it was gone, the type of eye found in *Troglichthys* would be reached without passing through a stage found in *Amblyopsis*, it would be simply a horizontal contracting of the retina, not a collapsing of the entire eye.

The question may with propriety be asked here, do these most degenerate eyes approach the condition of the pineal eye? It must be answered negatively.*

* The degree of degeneration reached in the eye of *Troglichthys* which began to degenerate comparatively recently would lead one to expect the pineal eye to be much more degenerate than it is actually found to be in the lizards unless its functions were something aside from light perception.

Ontogenic degeneration.

The simplification of the eye in *cornutus* with age has been mentioned in the foregoing paragraphs. The nuclear layers are thinner in the old than in the young. There is here not so much an elimination or destruction of elements as a simplification of the arrangements of parts, comparatively few being present to start with.

The steps in ontogenic degeneration can not yet be given with any degree of finality for *Amblyopsis* on account of the great variability of the eye in the adult. While the eyes of the very old have unquestionably degenerated, there is no means of determining what the exact condition of a given eye was at its prime. In the largest individual examined the eye was on one side a mere jumble of scarcely distinguishable cells, the pigment cells and scleral cartilages being the only things that would permit its recognition as an eye. On the other side, the degree of development was better. The scleral cartilages are not affected by the degenerative processes and are the only structures that are not. The fact that the eyes are undergoing ontogenic degeneration may be taken, as suggested by Kohl, that these eyes have not yet reached a condition of equilibrium with their environment or the demands made upon them by use. Furthermore, the result of the ontogenic degeneration is a type of structure below anything found in phylogeny. It is not so much a reduction of the individual parts as it is a wiping out of all parts.

PLAN AND PROCESS OF PHYLETIC DEGENERATION.

Does degeneration follow the reverse order of development, or does it follow new lines, and if so, what determines these lines?

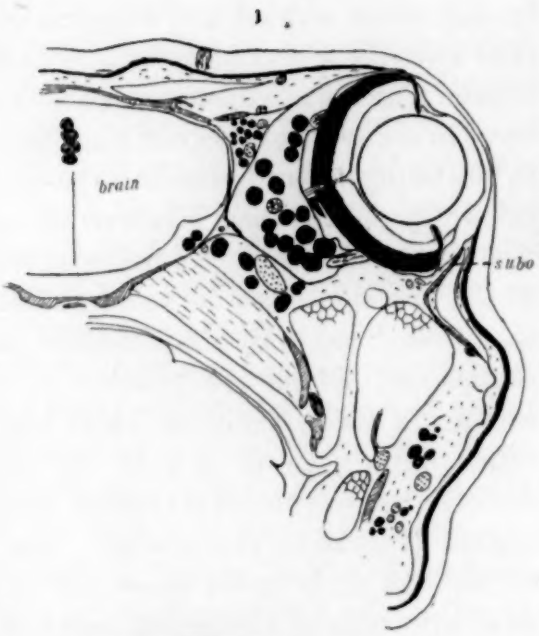
Before discussing this point I should like to call attention to some of the processes of ontogenic development concerned in the development of the eye. There are three processes that are of importance in this connection: 1. The multiplication of cells. 2. The arrangement of cells including all the processes leading to morphogenesis. Frequently the first process continues after the second one has been in operation. 3. Lastly we have the growth and modification of the cells in their respective places to adapt them to the particular function they are to subserve—histogenesis.

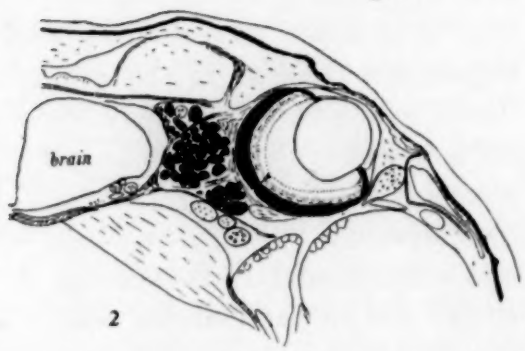
Since the ontogenetic development of the eye is supposed to follow in general lines its phylogenetic development the question resolves itself into whether or not the eye is arrested at a certain stage of its development and whether this causes certain organs to be cut off from development altogether. In this sense the question has been answered in the affirmative by Kohl. Ritter, while unable to come to a definite conclusion, notes the fact that in one individual of *Typhlogobius* the lens, which is phylogenetically a new structure, had disappeared. But this lens had probably been removed as the result of degeneration rather than through the lack of development.

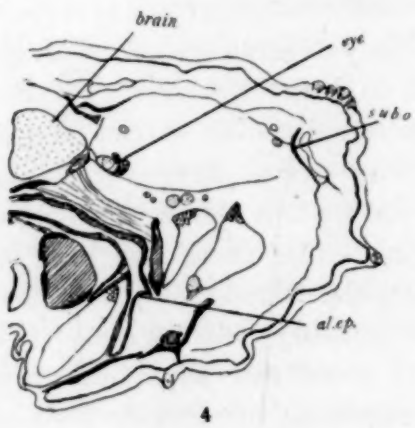
Kohl supposes that in animals placed in a condition where light was shut off, more or less, some of the developmental processes are retarded. In successive generations earlier and earlier processes in the development of the eye are retarded and finally brought to a standstill; thus every succeeding generation developed the eye less. Total absence of light must finally prevent the entire *anlage* of the eye, but time, he thinks, has not been long enough to accomplish this in any vertebrate. The cessation of development does not take place at the same time in all parts of the eye. The less important, those parts not essential to the perception of light, are disturbed first. The retina and the optic nerve are the least affected, the iris comes next in the series. Because the cornea, aqueous and vitreous bodies and the lens are not essential for the performance of the

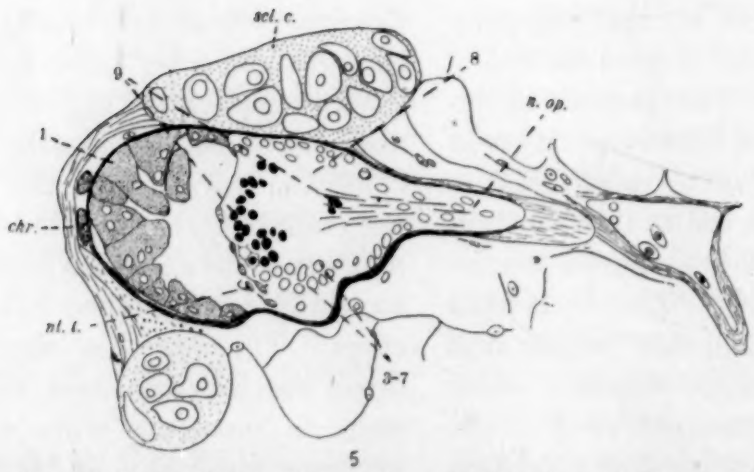
function of the eye, these structures cease to develop early. The processes of degeneration follow the same rate. Degeneration is brought about by the falling apart of the elements as the result of the introduction of connective tissue cells that act as wedges. Abnormal degeneration sometimes becomes manifest through the cessation of the reduction of parts that normally decrease in size (p. 269), so that these parts in the degenerate organ are unusually large.

Kohl's theoretical explanation is based on the study of an extensive series of degenerate eyes. He has not been able to test the theory in a series of animals actually living in the condition he supposes for them, and has permitted his erroneous interpretation of the highly degenerate eye of *Troglichthys* to lead him to the theory of the arresting of the eye in ever-earlier stages of ontogeny. The eye of *Troglichthys* is in an entirely different condition from that supposed by him. The mere checking of the normal morphogenic development has done absolutely nothing to bring about this condition and it could not have been produced by the checking of development in ever earlier and earlier stages of ontogeny, for there is no stage in normal ontogeny resembling in the remotest degree the eye of the adult *Troglichthys*. The process of degeneration as seen in the Amblyopsidæ is in the first instance one of growing smaller and simpler (not more primitive) in the light —not a cutting off of late stages in the development in the dark. The simplified condition, it is true, appears earlier and earlier in ontogeny till it appears along the entire line of development, even in the earliest stages. This simplified condition never gives any evidence of being more primitive; it is simply less elaborate. The tendency for characters added or modified at the end of ontogeny to appear earlier and earlier in the ontogeny is well known, and there is no inherent reason why an organ disappearing in the adult should not eventually disappear entirely from ontogeny. The fact that organs which have disappeared in the adult, have in many instances not also disappeared in the ontogeny and remain as so-called rudimentary organs has received an explanation from Sedgwick. In his re-examination of the biogenetic law he came to the conclusion that "the only functionless ancestral structures, which are present in development, are those which at some time or another have been of use to the organism during its development after they have ceased to be so in the adult." The length of time in such cases since the disuse of such an organ in the young is much shorter than that since its use in the adult. All organs functionless in the adult, but functional in the early ontogeny, develop in the normal way. Organs no longer functional at any time dwindle all along the line of development. In *Typhlogobius*, where the eye is functional in the young, it develops to full size in the embryo and it is not till late in life that degeneration is noticeable. In *Amblyopsis* on the other hand, where the eye has not been functional at any period of ontogeny for many generations where the eye of both the young and adult lost their function on entering the caves, and where degeneration begins at an early period and continues till death, the degenerate condition has reached the early stages of the embryo. It is only during the first few hours that the eye gives promise of becoming anything more than it eventually does become. The degree of degeneration of an organ can be measured as readily by the stage in ontogeny when the degeneration becomes noticeable as by the structure in the adult. The greater the degeneration the further back in the ontogeny the degenerate condition becomes apparent unless, as stated above, the organ is of use at some time in ontogeny. It is evident that an organ in the process of being perfected by









1. Part of the section of the head of *Chologaster papilliferus* at the optic nerve ; subo.-suborbital.

2. Part of the section of the head of *Chologaster agassizii*.

3. Part of the section of the head of an *Amblyopsis* showing the location of the eye ; subo.-suborbital. scl., scleral-cartilage.

4. Part of the section of the head of *Troglichthys* passing through the eye ; al. ep., alimentary epithelium.

5. The most degenerate vertebrate eye known, that of *Troglichthys* in vertical section. 1, pigment layer of the retina ; 3–7, retina from the pigmented layer to the inner reticular layer; 8, inner reticular layer; 9, ganglionic layer; n. op., optic nerve; nl. l., nuclei of the hyaloid; chr. choroid pigment; scl. c., scleral cartilages.

selection may be crowded into the early stages of ontogeny by post selection. Evidently the degenerate condition is not crowded back for the same reason. How it is crowded back I am unable to say. A satisfactory explanation of this will also be a satisfactory explanation of the process by which individually acquired characteristics are enabled to appear in the next generation. The facts, which are patent, have been formulated by Hyatt in his law of tachygenesis.

Cessation of development takes place only in so far as the number of cells are concerned. The number of cell generations produced being continually smaller, result in an organ as a consequence also smaller. In this sense we have a cessation of development (cell division, not morphogenic development) in ever earlier stages. That there is an actual retardation of development is evident from *Amblyopsis* and *Typhlichthys* in which the eye has not reached its final form when the fish are 25 mm. long.

Histogenic development is a prolonged process and ontogenic degeneration is still operative at least in *Amblyopsis*.

Degeneration in the individual is not the result of the ingrowth of connective tissue cells as far as I can determine. It is rather a process of starving, or shriveling and resorption of parts.

From the foregoing it is evident that degeneration has not proceeded in the reverse order of development, rather the older normal stages of ontogenic development have been modified into the more recent phyletic stages through which the eye has passed. The adult degenerate eye is not an arrested ontogenic stage of development but a new adaptation and there is an attempt in ontogeny to reach the degenerate adult condition in the most direct way possible.

CARL H. EIGENMANN.

SCIENTIFIC BOOKS.

The Ore Deposits of the United States and Canada. By JAMES FURMAN KEMP. Third Edition entirely rewritten and enlarged. New York and London, The Scientific Publishing Company. 1900.

The first edition of 'Kemp's Ore Deposits of the United States' appeared in 1893. The second edition from the same plates, in which forty to fifty pages of additional matter had been inserted, was published in 1895. We now have the third edition, with entirely new plates, which forms a volume nearly twice as thick as the first, with larger type, heavier paper and additional plates which contribute, as well as the new matter, to its increased size. As this is practically the only modern work dealing in any adequate fashion with this important subject, and as it hence constitutes the standard work for reference with regard to the ore deposits of the United States and Canada, it is important to consider its shortcomings as well as its merits, and even to dwell upon the former.

It must be evident to all who consult the work that Professor Kemp has been remarkably thorough in his search of the literature of his subject and few books have a more complete bibliography; the references, moreover, are distributed throughout the text, not lumped together at the end, so that it requires very little labor on the part of the reader to go back to original authorities on any given point. Kemp possesses, moreover, in a high degree the important faculty of reading intelligently and of expressing concisely the leading facts gathered in the course of his reading. This is perhaps the most important qualification for a work that is essentially a compilation rather than an original treatise.

For a philosophical treatment of phenomena like ore deposits, in which different observers may in all honesty draw diametrically different conclusions from their respective examinations of the same deposit, it is essential that the author should have been able by personal inspection to verify the relative accuracy or degree of probability of opposing views; for in this case, even if we may differ with the author's theoretical opinions, we know that the coeffi-

cient of error, if such we regard it, will be constant through his work.

In the first edition of Kemp's work, there was some evidence of haste in preparation, for which, apparently, the publishers' demand for copy was in a measure responsible. In the later editions, there has been ample time to remedy any shortcomings that may have arisen from this cause, hence it is well to examine with some detail the nature of the changes that have been made in the last edition. The book is divided into two parts; Part II., a description of the deposits of the respective metals, occupying about five-sixths of the total space. In Part I., which deals with general characteristics, there has been added to Chapter I., on the 'Formation of Cavities,' a statement of Van Hise's division of the earth's crust into three zones, one of fracture, one of fracture and flowage combined, and one of flowage alone; also six pages on 'Underground Circulation,' but nothing to the very brief mention of 'Replacement as a mode of deposition.' In Chapter III., on 'Minerals and their source,' there has been added a paragraph on the association of certain metals with certain rocks, and one on secondary migrations of vein materials, with references to De Launay's recently expressed views. In Chapter VI., on the 'Classification of Ore Deposit,' the author has elaborated the discussion of his own system; especially in the direction of magmatic differentiation, relegating the descriptions of other systems to an appendix at the close of the work; the other three chapters are practically unchanged.

It is in the descriptions in Part II. that the most changes have been made, and these have been mainly as insertions of new paragraphs, so that the statement on the title page that the volume has been 'entirely rewritten,' for which the publishers are evidently responsible, is hardly justified. The actual increase in the number of pages is one hundred and eleven, but this is in considerable part due to larger type. It has evidently been considered important to preserve, as far as possible, the same relative numbering of paragraphs in this as in former editions; new matter is largely taken from new publications of Government surveys, and from papers in the transactions of the American Institute of Mining Engineers. The following are the more important changes in order of chapters:

In descriptions of 'Iron Deposits' important enlargements are made from the work of Van Hise and his associates in the Lake Superior region and from the author's studies in the Adirondacks. Under 'Copper Ores' the description of the Ducktown and Butte deposits have been largely rewritten, and those on the 'Lake Superior Deposits' have been elaborated; mention is made of some in Idaho. Additions have been made to the discussions of the Lead and Zinc Deposits of the Mississippi Valley from the reports of Winslow and Jenney; in the chapter on 'Zinc alone,' no change is perceptible. Under 'Lead and Silver' new descriptions are given of the Tenmile, Eagle River and Aspen districts in Colorado (the latter rather inadequate), and under 'Silver and Gold' of the Telluride, Custer County and Cripple Creek districts, in the same State. Under the same head, hitherto unpublished data is given from a paper by J. D. Irving on the Black Hills' Deposits, which, like those of Cripple Creek, are more properly classed under 'Gold alone.' New data as to Montana, Idaho and Utah, are added on the authority of Weed, Lindgren and Spurr, respectively. Descriptions of the 'Gold Deposits of the Pacific Slope' are very largely rewritten from the reports of Lindgren, Becker, Turner and others. Under the heading 'Gold elsewhere in the United States and Canada,' the gold deposits of the Appalachians, which have been barely noticed before, are briefly described, mainly from Becker's report; but of the eight pages of text fully one-half are occupied by references. Eleven pages are given to Alaska and British Columbia, with notes on Nova Scotia. About eighteen paragraphs have been added to the chapter on the 'Lesser Metals' in which those that bear upon the theory of magmatic separation are especially prominent.

The improvement in the illustrations of the volume is most marked, as there were very inferior reproductions in former editions; some of the poorest have been eliminated, and the half-tone prints, both old and new, are of remarkably improved quality, though some still leave much

to be desired (*e. g.*, Fig. 122). The new illustrations are largely from Government reports, but many photographs are by individuals, especially by the author. From these it appears that, since the publication of the first edition, the author has himself visited some of the important mining districts of the west, but in many cases it is evident he still does not possess sufficient familiarity with the regions to judge, from published reports of a given mining district, whether or not those of one author possess inherent merits entitling his views to superior consideration over those of another.

Professor Kemp, who is an excellent petrographer, has, as shown by his papers published elsewhere, a decided leaning toward the theory of magmatic separation of ore minerals held by Scandinavian geologists, like them, viewing the subject primarily from a petrographic standpoint. The sufficiency of this method for the formation of ore deposits, unless aided by later concentrations through the agency of circulating waters, is not, however, regarded with so much favor by most mining geologists of wide practical experience in America.

Taken as a whole the book presents an excellent bird's-eye view of the ore deposits of the country, as nearly up to date as is practicable, with a fair-minded presentation of the various views held as to their origin and mode of formation. The mining community is certainly indebted tc Professor Kemp for the ability and thoroughness with which he has accomplished his laborious task, the magnitude of which few beside the author can adequately appreciate.

S. F. EMMONS.

The Nature and Work of Plants. An Introduction to the Study of Botany. By DANIEL TREMBLY MACDOUGAL, Ph.D., Director of the Laboratories, New York Botanical Garden. New York, The Macmillan Company. 1900. Pp. xviii + 218. 12mo.

The author's introductory paragraph gives us his point of view. "The course outlined in this little book is essentially a study of the functions or action of the plant, and organs are considered chiefly as instruments for the performance of work, with but little attention to their morphology. It is believed that this method of introduction to the subject of botany will be best suited for beginners who have not at hand the facilities of a laboratory. In conformity with this idea, the use of technical terms has been restricted to the actual necessities of logical treatment, and the demonstrations have been developed by the simplest experimental methods."

He takes up the subject in ten chapters, as follows: I. the composition and purposes of plants: II. the material of which plants are made up; III. the manner in which different kinds of work are divided among the members of the body; IV. the roots; V. the leaves; VI. stems; VII. the way in which new plants arise; VIII. seeds and fruits; IX. the power or energy of the plant; X. relations of plants to each other, and the place in which they live. These chapters include two hundred and fifty paragraphs, each of which directs attention to a single fact or group of facts, which in most cases may be subjected to observation or experiment by the pupil. Very simple suggestions are given for these observations and experiments, and the pupil is usually left quite free to use his own ingenuity in carrying them out. While function is emphasized, structure is not ignored, but this is almost entirely confined to gross structure, the author's intention being to require no greater aid to the naked eye than a hand lens magnifying from six to ten diameters.

The book is non-technical, in conformity to the trend of recent text-books, and is remarkable in having *no illustrations whatever*, the author depending upon the simplicity and clearness of his text and the plant or experiment itself to furnish ideas to the pupil. Whether the pupils and teachers who have been brought to expect fine 'half-tone' illustrations of everything from cell elements to plant communities, and a profusion of diagrams of physiological apparatus, with 'half-tones' showing the results of experiments, will take kindly to this book which implies and demands *work* on the part of both, remains to be seen. There is a good deal of laziness in the world, and we fear that the temptation to use a book with pictures (which too often are studied in lieu of the experiments) may be so strong as to

prevent the general use of Dr. MacDougal's book.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

De praktische toepassing van Stoomschuif- en Schaarbewegingen bij Stationaire, Locomobiel-, Locomotief- en Scheeps-machines door C. STEUERWALD; Mit eene voorede van H. A. RAVENEK. By W. S. AUCHINCLOSS. Leiden. A. W. Sijthoff. 1899. Pp. 108. Many illustrations.

This book is a translation, into the Dutch, of Auchincloss' well-known treatise on valve-motion, of which a German version has long been in type. The translator is a member of the Faculty of the Polytechnic School of Delft; the introduction is written by Professor Ravenek of the same institution. There is no lack of such works in the English, German and French languages; but the work of Auchincloss excels in the simple and very clear manner in which the graphical constructions are made, "without preceding calculations, simply by outlines on the drawing-board," as Professor Ravenek says in his introduction. The treatise is adjudged 'very suitable to be placed in the hands of apprentices and draughtsmen' as well as of students in mechanical engineering.

The British measures of the original are replaced in the translation by metric.

This reproduction of the American work in Dutch is one of the most gratifying testimonials to the value of the work which has yet appeared. The book is unusually well-printed and its illustrations are exceptionally well-made.

R. H. T.

Mesure des température élevées. Par. H. LE CHATELIER et O. BOUDOUARD. Paris, G. Carré et C. Naud. 1900. Pp. 1–220.

In these few pages Le Chatelier and his assistant have given a terse and useful account of the principal methods of cotemporaneous pyrometry. Measurement of high temperature has, as a rule, referred to the comparison of different temperature functions, and the results obtained have therefore differed enormously. The confusion has gradually subsided however, in proportion as the air thermometry of high temperatures has been more fully mastered. Le Chatelier makes a judicious selection of standard temperatures in the introductory chapters of his book and estimates the probable error to be 1° between 200° and 500°, 5° between 500° and 800°, 10° between 800° and 1100° and upwards 50° above 1100°. In the list of pyrometers which follows I should have referred the calorimetric pyrometer to Pouillet and perhaps included the viscosity pyrometer.

The brief account given of normal temperatures as defined by Kelvin and their relation to the air thermometer is intelligible, well digested and practical in character, though these corrections at high temperatures are of small moment. An account is also given of the standard (hydrogen) air thermometer of the Bureau International at Sèvres, which may be taken as a preliminary model, since the normal air thermometer for high temperatures has not yet been constructed. The authors might have added that very definite steps are being taken in this direction by Holborn and Day at the Reichsanstalt. It has been shown that the platinum-iridium alloy is impervious to nitrogen rigid up to the highest industrial temperatures. Nothing now stands in the way to prevent high temperature measurements from attaining the full precision of low temperature measurements.

The errors usually encountered in high temperature thermometry make up Chapter III. of the book, after which various historical pyrometers are described from figures, and critically discussed. It is interesting to note that the errors of Pouillet were largely due to the high value of the coefficient of expansion then in vogue. Among the whole series the interferential pyrometer of D. Berthelot may be singled out as being peculiarly promising, both on account of the simple and apparently correct principle on which it is based, and on account of its indefinitely high temperature limit of application.

In preference to platinum which is expensive and iron which behaves anomalously, nickel has been recently proposed for calorimetric pyrometry. The authors give a series of appropriate data, and figures of available apparatus, together with the probable inaccuracies of this

somewhat unsatisfactory method of pyrometry. Incidentally it may be appropriate (as for instance in the case of Violle's famous experiments) but it now has little general laboratory value.

The resistance pyrometer, introduced by Siemans and perfected by Callendar and Griffiths, is for shorter ranges of high temperature (0°–1000°) now without a rival in accuracy. It has the additional advantage of continuous registry almost as far down as the absolute zero of temperature. Calibrated with reference to Callendar's equations by aid of the specially determined boiling point of sulphur (an error was detected in Regnault's value by this very instrument), it is also a convenient instrument in practice.

The chapter on thermoelectric pyrometry, in which Le Chatelier is specially interested is naturally very full, at least in relation to the D'Arsonval method of measurement. This is obviously the more practical though the zero methods give a permanent record. Figures are abundantly inserted of the galvanometers, furnaces, crucibles, and the other necessary paraphernalia of the pyrometric laboratory.

The chapter on radiation pyrometry is antiquated and meagre, inasmuch as nothing is said about the remarkable results of Wien, Lummer, Kurlbaum, not to mention Planck and others who are remodeling the whole subject. So also the mention made of the bolometer is altogether inadequate. On the other hand Le Chatelier enters at length into photometric radiation pyrometry which is of secondary interest by comparison.

The final chapters contain interesting information on Wedgewood pyrometry and on Seeger cones, recipes being given in detail. The book closes with the remarkable work which Roberts-Austen is now doing with his self-registering pyrometer and the new differential method of observation.

The book as a whole is obviously an outgrowth of the laboratory and is supplemented by personal observation. As such it needs no further recommendation.

C. BARUS.

BROWN UNIVERSITY,
PROVIDENCE, R. I.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

THE 99th regular meeting was held at the Cosmos Club, March 14, 1900.

Under informal communications, Mr. J. A. Taff exhibited some asphalts from Indian Territory, and briefly described their occurrence.

On the regular program the following papers were presented:

(1) 'Glacial Sculpture in the Bighorn Mountains,' by Mr. F. E. Matthes.

The glacial cirques on the Bighorn Range are exceptionally well preserved and complete in outline. The crests and spurs separating them have remained unglaciated, and are remnants of pre-glacial topography. The cirques do not necessarily develop at the heads of the pre-glacial alpine valleys. In numerous cases the upper ends of the latter have remained unglaciated while cirques have formed lower down. This raises the question: What are the conditions necessary for the formation of a cirque; or, since a cirque is essentially the product of frost-action in the bergschrund, what determines the location of the bergschrund?

It was shown that the unglaciated areas above the bergschrunds were covered by *quiescent névé* during the period of glaciation. They were *nivated*. The effects of *nivation* are the accentuation of abrupt slopes and the effacing of the pre-glacial drainage lines by deposits of powdered rock produced by frost-fracturing along the edges of the névé sheets. The bergschrunds constitute the boundary between the *nivated* and *glaciated* areas.

According to the evidences gathered in the Bighorn Mountains the location of the bound ary line is intimately connected with the depth of the valleys, or, more strictly, with the depth of the névé. That the spheroid of the mean annual temperature of 32° F. does not influence its location is demonstrated by the fact that cirques and nivated areas exist side by side at all elevations from 10,000 feet up to 13,000 feet.

The conclusion is that névé may remain stationary or acquire motion at any of these elevations, regardless of the altitude of the spheroid of 32° F. The only factor which determines whether a body of névé shall have motion or not is its depth.

(2) 'Physiography of the Arkansas Valley Region,' by Mr. Geo. I. Adams.

This is essentially a gradation plain, below which lie the present stream valleys, and above which rise numerous residual hills, ridges, mesas and mountains, to elevations usually not greater than 200 feet. The mountains which occupy the broader synclines, however, may rise from 1500 to 2300 feet above sea-level. The rocks have been thrown into open folds, with east and west trend. There is little faulting. The northern limit of the region is the Boston Mountains, having a monoclinal structure and forming the southern edge of the Ozark Plateau. To the south it is limited by the closely folded and faulted structure of the Ouachita Mountains.

The Arkansas Valley Region may be considered as an extension of the Prairie Plains eastward through the mountains of Indian Territory and Arkansas to the Gulf Plains. It shows evidence of an earlier erosion period in which the streams flowed at relatively higher levels. It may be compared with the Appalachian Valley region in its structural and physiographical relations.

F. L. Ransome,
David White,
Secretaries.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 320th meeting, held on Saturday, March 10th, was devoted to an address by Dean C. Worcester on 'The Birds and Mammals of the Philippines' which was illustrated by lantern slides. The speaker dwelt particularly upon the distribution of the birds, showing the part played by deep straits as barriers to migration between the islands, and stating that the Bornean aspect of the fauna was confined to Palawan and the adjacent small islands. The difficulties of collecting in the Philippines were described, but it was pointed out that these islands offer exceptional opportunities for the zoologist and that a careful study of the fauna might be expected to throw much light on the problems of specific and individual variation.

F. A. Lucas.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

The regular meeting of the Section was held on Friday, February 23d. The first paper of the evening, entited 'Symbolism of the Huichol Indians,' was presented by Carl Lumholtz. The Huichols are a small tribe of about 4000 souls living in the southwestern part of Mexico, on a spur of the Sierra Madre. Their country being difficult of access, they have been left comparatively untouched by civilization, and thus preserved their ancient beliefs and customs intact to the present day. The paraphernalia of the warrior of ancient times, *i. e.*, of the gods of the present race, furnish the principal symbolic objects by which prayers are expressed, and the most important of these articles is the ceremonial arrow left as a sacrificial offering in the temples and considered a carrier of prayers. It is painted and otherwise decorated with symbolic emblems, and attached to it are representations of other paraphernalia of the warrior, as the front-shield and the back-shield, the latter being also viewed as the mat or bed of the god. Frequently the object of the prayer is incorporated in an attachment to the arrow. The vivid imagination of the people makes them see analogies in the most heterogeneous phenomena. They see serpents in the sky, the clouds moving through space, the wind sweeping over the fields, the rain falling down, even in their girdles and ribbons. Certain insects which appear during the wet season are identical with corn, and corn is identical with hikuli, and hikuli identical with deer. The same tendency to consider heterogeneous objects as identical may be observed in the fact that a great variety of objects are considered as plumes. Clouds, cotton-wool, the white tail of the deer, the deer's antlers, and even the deer itself are plumes, and the serpents are believed to have plumes. Naturally, much ambiguity is found, and there are few symbols that express always the same meaning; nor is an idea always expressed by the same symbol. Although this gives a certain individuality to the symbolic objects, we can always trace the connection between the thought to be expressed and the symbol expressing it. The second paper on 'Symbolism of the Arapahoe Indians' was read by A. L. Kroeber. It was shown with the aid of lantern slides that the decorative art of the Arapahoe Indians is throughout realistic (*i. e.*, pictorial) or symbolic.

Geometric patterns occur, but rarely, and the general character of the art is suggestive rather of pictography. Symbols representing animal life, physical nature, and abstract ideas predominate.

Dr. Franz Boas presented a paper on 'The Growth of Children.' A series of measurements of children repeated at annual intervals proves that the variations of growth must be interpreted as mainly due to acceleration and retardation of growth, combined with hereditary influences, which determine the amount of annual growth. It was shown that it is possible to determine the essential elements which determine the amount of annual growth by admission of regulated measurements. These result in a determination of (1) the relation between final development and development at any given period; (2) the typical development at a given period; and (3) the variability of the series in regard to period.

CHARLES H. JUDD,
Secretary.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO.

AT the meeting of January 10th, Mr. R. H. Johnson presented a paper prepared in collaboration with Mr. R. W. Hall, entitled 'Variation in *Palaemonetes* correlated with Salinity.' After calling attention to the fact that our marine species of *Palaemonetes* differ from the fresh-water form in presenting a greater number of rostral teeth, Mr. Johnson stated that various lots of the marine species which were collected in brackish water show an intermediate condition as regards the rostral teeth. A complete series of intermediate forms exists and the natural inference is that the different degrees of salinity cause the observed differences in form. The experiment of rearing the animals in media of different degrees of salinity has not yet been made by the authors, but will be attempted, as this alone will afford complete evidence in regard to the matter.

The second paper of the meeting was a review by Mr. A. N. Young of several recent papers, by Edmond Bordage, on regeneration in insects.

The second meeting of the month was held on January 31st. The first paper of the session 'A Review of Bresslau's paper on the Develment of the Rhabdocoels,' was presented by Mr. E. H. Harper.

The remainder of the session was occupied by an exhibition of a very interesting series of the extremely variable land snail *Pyramidula strigosa* Gould, collected by Hemphill from the Great Basin, a loan from the Powell Museum of the Illinois Wesleyan University through the kindness of Professor J. C. Hartzell. Attention was called to the direction taken by some of the variations. The recorded localities seem to indicate that some of the varieties are quite local in their distribution and that there is distinct geographical isolation. It was suggested that the history of the topography might throw light upon this isolation. Gilbert's map of 'Lake Bonneville' shows that the Oquirrh Mountains (the locality for the *Oquirrhensis* and *Utahensis*) were then situated upon a narrow peninsula. Climate may have since aided in preserving this isolation. This species is of special interest to students of evolution and well deserves to be better and more widely known.

C. M. CHILD.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis on the evening of February 19, 1900, 43 persons were present. Professor Patrick Geddes, of University College, Dundee, in an address of about an hour, traced the increasingly complex relation of the world to science and the rapidly increasing need of co-ordination of the sciences, and then gave a concise account of the purposes which it is hoped to realize and the methods to be adopted by the International Association for the Advancement of Science, Art and Education, which grew out of the meetings of the British and French Associations for the Advancement of Science last autumn, and is to hold its first international assembly at the Paris Exposition in the course of the present year, the purpose of the Association, recognizing the wealth of instructive material brought together by the great transient museums, the World's Fairs, being the fullest possible utilization of the educational facilities so brought together.

On the conclusion of Professor Geddes' address, Hon. D. R. Francis, on the call of the President, spoke briefly on the subject presented by Professor Geddes, expressing a warm interest in the work of the Association, the cooperation of which with the Louisiana Purchase Exposition being planned for St. Louis, a few years hence, is hoped for.

A paper by Dr. G. A. Miller, 'On the primitive substitution groups of degree ten,' was presented by title.

Professor J. L. Van Ornum, late of the United States Engineer Corps, spoke interestingly on 'The sanitary cleaning of a city, as exemplified by Cienfuegos, Cuba,' explaining the conditions found by the United States Army on taking possession of that city, and the thoroughness with which the streets, court yards and cesspools were cleansed by the Engineer Corps, which also charged itself with the betterment of the city water supply. A diagram which the speaker had prepared showed that in addition to a very marked lowering of the death rate which attended the supply of an abundance of wholesome food, on the occupation of Cienfuegos, there had been a decrease of considerably over fifty per cent. in the weekly death rate, directly attributable to the sanitary cleansing of the city; and he further stated that since this work had been done, yellow fever, which before that time had been endemic in Cienfuegos, had been absent from the city.

Five persons were elected to active membership in the Academy.

William Trelease,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

'FLOATING SAND.' 'FLOATING STONES.'

In the *American Geologist* for January, 1896 (Vol. XVII, pp. 29–37) I published an article on 'Floating Sand: an Unusual Mode of River Transportation' in which I gave a detailed account of that phenomenon as seen by me during the preceding August on the Llano river, a tributary of the Colorado, at Bessemer, a station on the Austin and Northwestern Railroad, 94 miles from Austin, Texas. I further gave an account of numerous experiments performed for the purpose of ascertaining how sand may be floated, what sand will float, and why sand will float. No less than fourteen different sands were examined some of which were from widely separated localities, as, for instance, the coast of Long Island and that of Lake Michigan, at Chicago; from the friable sandstone at Alum Bay, Isle of Wight, and the Lower Carboniferous at Pea Ridge, Arkansas. At the time of writing, I may add, the only account of floating sand known to me was in a brief article 'On a Peculiar Method of Sand-Transportation by Rivers' published by Mr. James C. Graham in the *American Journal of Science*, III, Vol. XL, p. 470 (December, 1890) and this I had failed to notice until I had begun my investigations.

Without going into the details of my paper further at this point, I will enumerate the conclusions reached which were as follows:

"1. That sand grains will float in perfectly still water for an indefinite time.

"2. That the grains which float are not necessarily siliceous. That flakes of mica, fragments of marble, bituminous shale, etc., also float and that some of them, the marble and the bituminous shale, for example, are unusually buoyant.

"3. That the property of floating is not confined to the sand of any particular locality, but depends to a considerable extent upon the angularity, *i. e.*, the shape of the grains.

"4. That whether sand will float or not depends, also, upon the mode of launching. Whether it be by ripple waves, as stated by Mr. Graham, or by undermining, it must be gently done, for should the grains be plunged into the water with sufficient force to completely immerse them they will immediately sink.

"5. That the natural conditions necessary to the floating of sand in rivers are somewhat unusual, depending, in the case of the Llano, upon a flood without local rains and, in that of the Connecticut, upon the manner in which certain waves strike a sand-bar. It is quite possible, however, that floating sand is much more common than is ordinarily supposed.

"6. That the physical explanation of the problem is complex rather than simple, and at best unsatisfactory in several important particulars, and that with the advance of molecular physics we may hope for a better understanding of what we now, for convenience, term 'superficial viscosity' and 'capillary attraction.'"

This article attracted considerable attention and was reprinted entire or in part in other journals.

Among the letters received at the time of publication, the following substantiate the last part of the 5th conclusion, viz, that floating sand is much more common than is ordinarily supposed:

Professor William Morris Davis wrote, January 28, 1896: "I have noticed the same thing (floating sand) on the tidal currents of Cape Cod."

Mr. Henry W. Nichols of Field Columbian Museum, Chicago, wrote, February 3, 1896:

"I would like to add another instance. At Cohasset, Mass., a town about twenty-five miles south of Boston, there is a land locked inlet from the sea, known as Little Harbor. There are here and there along its shores, small beaches of angular gravel and sand. When there is no wind, the tide rises gently on these beaches without even a ripple, and gently lifts grains of dry sand which form such patches as you describe a foot or more in diameter. Some days such floating patches are very numerous, and may be seen going out with the tide all the way from the head of the Harbor to the outlet over a mile distant. The rock of the region is granite and the sand is probably derived from it. The grains are very angular. Without thinking much upon the subject, I have always considered that a film of air adhered to the grains and kept them from wetting, and that the floating was due to surface tension as in the case of the familiar experiment with a needle."

In the *American Geologist* for November, 1898, Professor George E. Ladd discussed the 'Geological Phenomena resulting from the Surface Tension of Water.' Under the caption 'Floating Materials' (p. 283) he says:

"It is not uncommon to see materials of a higher specific gravity than water floating upon its surface.

"The principle involved is again that of surface tension, and substances thus float only when the attraction for the water is less than the latter's surface tension.

"The geological results of this principle are chiefly the floating and shifting from place to place of sands. While I have observed such an occurrence on many occasions, in different places, the most important noticed was in Massachusetts, at the mouth of the Merrimac River. Here the northern end of Plum Island, which is a vast accumulation of sand, shuts in the harbor of Newburyport on the southeastern side. The action of the winds, of the waves, in time of storm, and the shifting currents (the position of the harbor's channel varying rapidly) result in the formation of numerous bays or 'basins' in the sandy island, on the protected side, often occupying extensive areas. The largest of these, having a circumference of something over a mile, has endured for the past forty or fifty years. The sand consists mainly of coarse, sharply angular quartz, but much feldspar is present, some mica, and numerous fragments of schistose and gneissic rocks. Whenever, on the retreat of the tide, the beaches and the exposed bars are dried by the sun's heat, the returning water, if not too greatly disturbed by unfavorable winds, lifts, as it creeps up the slope, the whole superficial film of sand, including large thin pebbles of schist, and floats it gently on the surface. The surface of the water, near the shores bearing the sand, commonly moves out towards the main river, even when the tide is rising, the incoming water flowing beneath.

"I have estimated that in the course of a year something like a thousand tons of sand, at a minimum, are lifted and borne away to new resting places by the floating power of surface tension at this locality alone."

During the present year Dr. Erland Nordenskiold's communication to *Nature* (January 18, 1900, p. 278) on 'Floating Stones,' seen by him during his recent visit to southwest Patagonia, has evidently been read with great interest in England and has been the means of calling forth a number of statements concerning floating sand and other mineral matter, such as fragments of shells. Neither Dr. Nordenskiold nor the other correspondents seem to have been aware of the papers published on that subject by Messrs. Graham, Ladd and myself, though printed in journals of wide reputation and extended circulation. Dr. Nordenskiold says:

"Whilst rowing in the long and narrow channel of Ultima Esperansa, to study the plankton, we observed, when the sea was calm or only agitated by a slight swell, small fragments of slate which floated upon the surface packed together in larger or smaller clusters. They drove hither and thither in the neighborhood of the shore, until they were driven away by the strong current which at intervals swept forward in the channel. The quantity was considerable; for instance, 700 of them were obtained at one cast of the net in a few minutes. The stones had evidently drifted out from the beach, which consisted mainly of similiar stone fragments washed off from the cliffs composed of a bituminous mesozoic slate. The

surface of the stones was dry, and they sunk immediately when it became wet by touching or by the movement of the swell.

"The slate fragments collected on the sea surface had a specific gravity of 2.71. The specific gravity of the water in the channel was only 1.0049 at a temperature of 15° C. (59° F.). The largest stone which I obtained from the surface weighed 0.8 gram. Twenty of the smaller fragments had a mean weight of 0.3 gram. The fragments contained no air cavities perceptible to the unaided eye."

These stones, which are pictured in *Nature*, are, it must be confessed, extraordinarily large. The specific gravity of the Llano sand was 2.59 and the largest grains could not approach the stones above mentioned in size.

To quote further from Nordenskiold:

"On examining the floating stones one could discern small gaseous bubbles attached to the under surface of them, and at the shore stones can be seen on the very fringe of the beach which are just beginning to float lightened by gaseous bubbles."

In my paper (p. 31) a possible explanation is offered for the presence of the 'gaseous bubbles': In one of my experiments I dug several holes in the sand forming a bank in the bed of the Llano and when their sides caved in, the dry grains forming the outer coat of the deposit, were gently launched and floated much more abundantly than in a previous experiment when the surface was damp. Furthermore, as each mass of sand slipped into the water, and exclusive of the floating grains, sunk, *the air contained in the interstices between the particles rose to the surface forming a patch of foam or froth.*

Again Dr. Nordenskiold remarks:

"It is probable that the stones were not only provided with gas bubbles, which can be perceived by the eye, but that they were surrounded by an envelope of gas supported by an insignificant coating of algæ, of which the stones are surrounded. At least, traces of diatoms and algæ are discernible on the stones after drying. The greasy surface of the mineral of which the stones consisted also prevented the water from adhering to them, and caused the stones to be surrounded with a concave meniscus, which naturally may have contributed to, and perhaps was the main cause of their floating, which sometimes was further facilitated by a patelliform shape of some of the bigger stones."

The floating sand of the Llano showed upon careful examination no signs of the presence of low forms of vegetable growth, neither was it in the least greasy. That the presence of oil in a bituminous shale may facilitate its floating property can scarcely be doubted.

Nature for February 1, 1900 (p. 318), contains two communications upon 'Floating Stones' by Messrs. Cecil Carus-Wilson and R. C. T. Evans, respectively.

Most of the points made by Mr. Carus-Wilson are covered in the papers of Messrs. Graham, Ladd and myself. It may, however, be of interest here to call attention to the following. He says:

"The grains float as patches composed of fine and coarse material clinging together; the presence of the very fine grains appears to facilitate the flotation of the larger grains and shells."

As bearing on this statement I will quote briefly from my paper:

"As I was sprinkling some sand upon the river for experimental purposes, a pebble almost as large as the end of my little finger fell into the center of a floating patch, which, to my great astonishment and delight, was depressed, like a funnel, for, say, half an inch before the cause of this unexpected phenomenon broke through its surface and sunk to the bottom" (p. 35).

His statement regarding the formation of 'patches' had also been anticipated in my paper (p. 36).

Mr. Evans writes that he has observed the phenomenon of floating stones at Kimmeridge, where the flaky nature of the beach material renders their appearance very common.

In experimenting with broken roofing slate he found that a small dried piece $1.5 \times .75$ cms. by about 1 cm. floats easily on water when gently placed on the surface.

It will be seen from the above statements that all observers agree that to float, the sand or stones must be lightly launched without complete wetting.

Frederic W. Simonds.
University of Texas.

SEA-BIRDS A SANITARY NECESSITY.

This country is on the verge of losing forever one of the main features of its seacoast charms—the sea-birds themselves. In fact, the Terns, the most exquisite of the Gull family,

which formerly thronged our whole coast, have been so nearly wiped out by agents of the milliners that this year's onslaught, already fully organized, will glean almost the last pair from the few small breeding colonies which remain, wherever these are unprotected. And the larger Gulls, which are not only very beautiful, but absolutely essential as harbor scavengers, are also being decimated for the same purpose.

All these species, with their exquisite beauty, their wild voices and their most romantic lives, peopling a realm which, without them, would be oppressive in its dreary grandeur, will reach their breeding places in a few weeks, and the Terns, especially, are liable to be slaughtered the moment they get there; therefore the promptest action is necessary, if we are to save even the few pairs of the latter which could restock our devasted coast when the evil eye of fashion shall have turned to other victims.

Simple economic considerations make it a matter of course that the Gulls *must* be saved. An immense horde of them, which naturalists think number anywhere from a hundred thousand to a million, gorge twice a day in New York Bay upon garbage. As the hour of the 'dump' approaches, their multitudes fill the whole air to an immense height, over an area of several miles, then gradually settle on the sea in vast white sheets. The whistle of the police boat, the signal to 'dump,' seems to waft them simultaneously into the air, to gather, like dense snow clouds, over the floating masses just emptied from the many scows.

Imagine from what an amount of putrid matter these birds, as big as hens, save the adjacent beaches, not to speak of their perpetual gleaning in the actual harbors! And this is a specimen of what occurs at every port. And shall this incalculable sanitary benefit, and all this beauty, terminate forever, and for no worthy purpose?

If money enough can be raised, the Committee of the American Ornithologists' Union will guard every breeding place where there is a law to back them, as Mr. Mackay and Mr. Dutcher have done at Vineyard Sound Islands and Great Gull Island. The utmost caution will be used in choosing wardens, and the Committee will be glad to receive names of men especially suited for the post. Light-house keepers and Life-Saving Station captains will be employed wherever feasible. A very encouraging sum is already in the hands of the Committee.

The places to be protected are certain islands on the coast of Maine, Long Island, New Jersey, Maryland, and perhaps Virginia and Florida. In Maine alone there is need of all the money we can possibly get, since there single wardens are afraid to face the rough plumers, and some more elaborate organization is the only hope.

The American Ornithologists' Union therefore appeals to every bird-lover for money to be used in hiring wardens to protect the birds while nesting. Contributions should be sent to Mr. William Dutcher, treasurer of the Union, at 525 Manhattan avenue, New York City, who will furnish all desired information.

ABBOTT H. THAYER, WILLIAM BREWSTER, Pres. Mass. Audubon Society; WITMER STONE, Chairman A. O. U. Com. on Bird Protection; ROBERT RIDGWAY, President A. O. U.; C. HART MERRIAM, Chief U. S. Biological Survey; Vice-Pres. A. O. U.; A. K. FISHER, Ass't. Biologist, U. S. Biological Survey; J. A. ALLEN, Curator Vertebrate Zoology, Am. Mus. Nat. His.; FRANK M. CHAPMAN, Ass't. Curator Ver. Zoology, Am. Mus. Nat. His.; WILLIAM DUTCHER, Treasurer A. O. U.

March 17, 1900.

NOTES ON ELECTRICAL ENGINEERING.

A NEW INDUSTRIAL SITUATION.

IN a pamphlet recently issued by the Westinghouse Companies, Mr. Geo. Westinghouse calls attention to the prospective use of the gas engine on a great scale for the generation of power and, in connection with central gas plants and pipe lines, for the distribution of power. Mr. Westinghouse says that "long familiarity with the electrical industry, the pipe line transportation of natural gas in great quantities, and an active interest in the development of large gas engines, satisfy me that the great economies which will result from the distribution of power by means of gas generated at central points, and conveyed in pipes along the lines of railway for the operation of gas

engines and electric generators, will be sufficient to justify the expenditure of the capital necessary for such installations in connection with the electrical equipment of railways, particularly metropolitan and suburban lines. The advantages of the use of gas engines can be best appreciated when it is understood that if a gas company were to supplant the present gas illumination by an equal amount of electric light obtained from gas-driven dynamos, it would have left for sale or other purposes over 60 per cent. of its present gas output."

In a communication to the New York *Times* of January 10, 1900, Mr. Westinghouse suggests the employment of fuel gas and gas engines for supplying light and power to the whole of Manhattan Island. He calls attention to the fact that city garbage is much better adapted for the manufacture of fuel gas than for use under a steam boiler, the large percentage of water in garbage being little or no disadvantage in the manufacture of fuel gas. He mentions the fact that fuel gas manufacture is a smokeless process, and he points out that the water consumption of gas engines may be kept far below that of steam engines. "Bearing on these questions" says Mr. Westinghouse "and of especial importance, are the partially executed plans of the electric power and light corporations, viz, the Metropolitan, Third Avenue and Manhattan Elevated Railways, the New York Gas and Electric Light, Heat and Power Company, and the United Electric Light and Power Company. If their present plans, which are fairly well known to the engineering profession, are carried to completion, each will have one large steam station on the East River between Twenty-ninth street and the Harlem River, with about 75,000 horse-power of engines, boilers, and electric machinery, making an aggregate of 375,000 horse-power, and which may be largely increased when the underground rapid transit railway is completed, and still further when the electric locomotive is used on all steam railways within the city limits.

"If these corporations were to unite in a common plan to provide the electricity needed in their operations by the adoption of the best available methods, the saving to each in capital expenditure would be very great, and the decreased cost of their supply of electricity would make an important addition to their earnings applicable to the payment of dividends; while, most important of all, the citizens of New York would have solved for them the garbage, smoke, and very largely the water questions.

"I believe the contemplated plans of the corporations above named, which can be shown to be based upon an imperfect knowledge of the subject, will stand in the way of vast public interests, and, so believing, I have said to representatives of some of these companies that the near future would demonstrate the projected power stations and systems of electrical distribution incidental to the character of such stations, to be as far from the best as are the old cable systems for the propulsion of cars."

It seems to the present writer that the recent improvements in the gas engine and the consequent commercial possibility of its use on a vast scale in the transmission and generation of power, warrant the title of the pamphlet issued by the Westinghouse companies 'a new industrial situation,' and it is a matter of especial satisfaction that the plan proposed by Mr. Westinghouse for New York City which promises such great benefits to the community, also commends itself to the business interests of the corporations concerned. Mr. Westinghouse's plan is entirely sound, at least the scientific and technical points involved are clear and certain, and it should engage the attention of every public spirited citizen.

WIRELESS TELEGRAPHY.

The Transactions of the American Institute of Electrical Engineers for December, 1899, contains an interesting discussion on wireless telegraphy. Professor R. A. Fessenden, in particular, describes some interesting experiments by himself and Professor Kintner. These two experimenters being unable to use the ordinary coherer as a measuring instrument, devised a small induction galvanometer (originally due to Elihu Thomson) for measuring the intensity of the electrical waves at the receiving station, and this induction galvanometer is said to be more sensitive than the coherer and well adapted as a receiving instrument in practice. Professor Fessenden also gives a good description, based

upon the mathematical work of Hertz, J. J. Thomson and Heaviside, of the character of the electrical waves which pass out from the vertical wire at the sending station; he calls attention to the rational basis for Marconi's law, or rather a modification of Marconi's law, that the range of signalling in miles is proportional to the product of the heights of the vertical wires at the sending and receiving stations, and explains why longer distance signalling is possible over water than over land. Those who are interested in this matter will find Professor Fessenden's discussion instructive and interesting.

Long distance wireless telegraphy seems to be now almost within reach, with high sending and receiving wires and with very powerful electrical disturbances at the sending station, very slight improvements in the sending and receiving apparatus will likely carry the range up to a thousand miles or more.

W. S. F.

CURRENT NOTES ON PHYSIOGRAPHY.

IOWAN DRIFT.

CONTINUED studies of the drift of Iowa by members of the State Geological Survey give new details regarding the topographic differences between the three chief drift sheets (Kansan, Iowan and Wisconsin), indicative of their differences of age. Calvin describes the Iowan drift sheet (*Bull. Geol. Soc. Amer.*, x, 1899, 107–120) as forming a broad plain of long, gently sweeping undulations, on which stream erosion has in general done little work; only the main drainage lines, many of which follow sags in the drift that are taken to indicate pre-Iowan valleys of erosion, are well defined; small lateral channels have been eroded only a mile or so from the main valleys. In contrast with this little carved surface, the Kansan sheet, next south, was maturely and deeply eroded before the Iowan sheet was deposited. The Kansan-Iowan interval is thought to have been fifty times the post-Iowan period. About the middle of the latter period is taken as the date of the lobe of Wisconsin drift that enters from Minnesota and overlaps both the Iowan and Kansan sheets. The surface of this lobate area shows even more distinct signs of youth than are found in the Iowan area; undrained depressions are of frequent occurrence on its undulating prairies; oxidation and leaching have hardly begun; stream erosion is insignificant. The value of topographical evidence as indicating geological dates is seldom better illustrated.

The same author described 'a notable ride' from the driftless area of northeastern Iowa to the Iowan drift sheet, where the contrasts of a maturely dissected upland of normal development, and the broad swells and troughs of a till plain are well presented (*Amer. Geol.*, xxiv, 1899, 372–377).

WESTERN AUSTRALIA.

AN account of part of western Australia by Cadell ('Some geological features of the Coast of Western Australia,' *Trans. Edinb. Geol. Soc.*, vii, 1897, 174–182) ascribes the absence of harbors to a recent slight elevation after prolonged denudation. The elevation is indicated by raised beaches, now 10 or 15 feet above sea level, one beach being from 12 to 18 miles wide and reaching 25 miles inland. The beaches lie on a low, flat plain of denudation, monotonous and desolate, sloping imperceptibly to the sea. An inland excursion of seventy miles was chiefly over a perfectly flat surface of granite, clay slate and other rocks, strewn with wind-worn pebbles and relieved by occasional crystalline knobs which rise over its prairie-like expanse. No mention is made of incised valleys; the few water courses of the region, usually with dry beds, seem to lie but little below the general level. The rocks are as a rule deeply weathered; water being commonly found in wells at depths of 45 or 50 feet. The inland termination of the plain is not described. The possibility of accounting for such a plan by subaërial or by marine denudation is recognized, and a preference is expressed for the latter agency in this case (although the deep weathering of the rocks seems to be more accordant with a subaërial history). A comparison is made between this denuded lowland and the flat pavement on which the Cambrian rocks of northwest Scotland rest; it is further suggested that if the Australian plain were scoured by glacial action, it would be transformed to a hummocky surface, resembling the 'rough

quarter' of the gneissic uplands of Sutherland (N. Scotland).

MOUNTAINS AND VALLEYS.

Richter of Graz writes on 'Gebirgshebung und Thalbildung' (*Zeitschr. deut. u. österr. Alpenverein*, xxx, 1899, 18–27), re-affirming the modern view that the bold forms of the Alpine summits result from the carving of valleys between them. He calls attention to the rough equality of height among the peaks of the Alps, and discusses the relation of peak height to valley spacing. He points out that in lofty ranges, the valleys must be relatively far apart, in order to allow the intervening mountain to rise to a great height. Before the greater uplift of the Alps, when the relief of the surface was less, streams and valleys were probably more numerous and closer together. As elevation progressed, some streams deepened their valleys faster than others and the side branches of the more active streams tapped the less active streams at many points and practically destroyed them; thus only the stronger streams survived in the deeper valleys. The rapid erosion of cliffs has reduced the mountain sides to a relatively uniform declivity, and the peaks are defined by the intersection of slopes propagated upward from the stream lines. Glacial action is briefly referred to as having produced trough-like channels whose side walls are steeper than the preglacial valley slopes which rise above them.

THE MEUSE IN BELGIUM.

After the Meuse trenches the Ardennes, it turns eastward along the strike of the Carboniferous rocks, receiving the Sambre from the western extension of the same geological belt. On this longitudinal course, streams of considerable length are received from the valleys of the Ardennes on the south, but the divide on the north lies close to the Sambre-Meuse, except at a few points where it locally loops northward. The streams that drain these loops receive a number of barbed headwaters which flow away from the Meuse valley before turning around towards it. The barbed headwaters are explained by Cornet as having once belonged to streams that flowed continuously northward. They have been captured by side streams of the Meuse in consequence of the depth to which its longitudinal valley has been cut (*Ann. Soc. géol. de Belgique*, xxvii, 1899). The beheaded streams, northward of their diverted headwaters, and their special relations to the valleys that they occupy are not described.

W. M. Davis.

NOTES ON INORGANIC CHEMISTRY.

A paper was read by Dr. Orme Masson before the recent Melbourne meeting of the Australasian Association on the use of Iceland spar as a standard in volumetric analysis, and is reprinted in the *Chemical News*. In Masson's method the pure spar in cleavage crystals is weighed in a beaker and then treated with 20 cc. of the acid to be standardized; after the first effervescence is over the whole is heated to boiling for an hour. The now perfectly neutral calcium chlorid is decanted off, the undissolved spar carefully rinsed in the beaker, dried at 110° and weighed. The loss in weight represents exactly the strength of the acid compared with normal, as 20 cc. of normal acid dissolves exactly 1 gramme of calcium carbonate. The method presents the advantages over the usual Iceland spar method, that there is no indicator used and no titrating of excess of acid with alkali—furthermore the crystals are less hygroscopic than the powder. The method has a further advantage over other methods in that few compounds can easily be obtained in so pure a state or of so definite composition as Iceland spar.

In a recent number of the *Bulletin* of the French Chemical Society Professor Moissan has described a definite phosphid of calcium with the formula Ca_3P_2. It may be formed by the reduction of calcium phosphate with carbon in the electrical furnace, or by the direct action of phosphorus vapors on calcium. In the former case it is crystalline, in the latter amorphous; in both a dark red solid. It is decomposed by water with the formation of phosphin, PH_3, in this respect resembling a number of binary compounds of calcium, such as calcium hydrid with evolution of hydrogen, calcium carbid with evolution of acetylene, calcium nitrid with evolution of ammonia. Lebeau has also

described recently arsenids and antimonids of calcium which on treatment with water yield respectively arsin AsH_3 and stibin SbH_3.

ANOTHER new compound of considerable interest, N_3I, has been prepared by Professor Hantzsch, of the University of Würzburg, and is described in the last *Berichte*. This is prepared by the action of iodin on the silver salt of hydrazoic acid, AgN_3. Unlike the other iodids of nitrogen which are dark brown, this is almost colorless. It seems to rather resemble the iodid of cyanogen CNI, which is formed in an analogous way, being soluble in water and of an almost intolerable odor. It is, however, very explosive, being even more unstable than the other iodids of nitrogen.

IN a recent number of *Nature*, R. A. Hadfield describes a contribution which his firm has made to the contest of armor plate *vs.* projectile. The latest improvement in the armor plate is that of Krupp, the composition of the steel used affording exceeding toughness and great tensile strength combined with high elastic limit. The surface is hardened by carburization by gas cementation instead of by charcoal, as in Harveyized plates. Against these plates ordinary projectiles are broken to pieces, their striking energy being wasted in breaking themselves instead of in perforating the plate. Hadfield's projectiles however, when used with a slightly higher velocity than the average usually employed, perforate these plates readily. These projectiles are fitted with a soft metal cap, which takes up a part of the energy which would otherwise be used in shattering the projectile.

IN this connection it may be added that the daily press has published a statement from T. A. Edison, Jr., that he has now devised a new armor plate which has a resistance much greater than the Krupp plate, so that for equal strength, the thickness of the plate can be reduced nearly one-half. At the same time the cost of the plate is very materially less than that of the Krupp or even of the Harvey plate.

THE preparation of some nickel bronze alloys is given by Sergius Kern of St. Petersburg, in the *Chemical News*. These alloys are especially prepared for fittings in high pressure marine boilers, and contain 70 per cent. copper, 17½ to 20 per cent. nickel, and the balance zinc. The alloys rust very slightly, have a tensile strength of 26 to 36 tons per square inch, and elongation of 14 to 17 per cent. in 2 inches.

THE discovery of a series of magnesium-aluminum alloys is reported in *Engineering*. When containing 10 per cent. magnesium the alloy resembles zinc, with 15 per cent. brass, and with 20 per cent. bronze. They give good castings and are resistant to the atmosphere, are fairly hard and work as well as brass. The alloys are lighter than aluminum and while possessing no great strength, are of value for many purposes where a light metal like aluminum would be used, if it could be cast and worked successfully. The inventor, Dr. Ludwig Mach has named the alloys magnalium.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

THE French Association for the Advancement of Science meet at Paris from the 2d to the 9th of August, under the presidency of General Sebert.

THE Ways and Means committee of the New York legislature has reported an item of $60,000 for the purchase of the scientific collections and library of the late Professor James Hall, State geologist and paleontologist for over sixty years. Should this report be sanctioned by the Senate and the Governor, the State Museum will acquire an immense collection in invertebrate paleontology, comprised principally of material from the New York formations. The library is the sum total of all the books brought together by Professor Hall during his remarkably long and active career and will make a unique addition to the State Library. It is hoped that no opposition will be manifested to the completion of this purchase.

PROFESSOR DAVID EDWARD HUGHES, the eminent physicist, has left the greater part of his large estate to four London hospitals, which will receive ultimately between $1,500,000 and $2,000,000. As these hospitals have medical schools attached to them, the money will doubtless be used in large measure for educational and scientific work. Professor Hughes also bequeathed $20,000 each to the Royal So-

ciety, and the Paris Academy of Sciences, the income to be used for prizes for original discoveries in physical sciences, particularly in electricity and magnetism. He also left $10,000 each to the London Institute of Electrical Engineers and the Paris Société International des Electriciens for scholarships and $5,000 to the Royal Institute for general purposes.

THE Royal Academy of Sciences at Berlin began on March 19th, the celebration of its 200th anniversary. The Academy was founded by Frederick I. in 1700, according to the plans of Leibnitz, who was its first president, but it was not opened until 1711. According to cablegrams to the daily papers, the Academy was addressed by the German Emperor, and among those present were Professors Moissan, De Pranqueville and Cenart, from France; Professors Mahaffy and Ramsay, and Mr. Thomas E. Thorpe, from Great Britain. Ambassador White represented the Smithsonian Institution, and Professor E. J. Wolff, of Harvard University, the American Academy of Arts and Sciences.

IT is said that the litigation over the estate of the late Dr. Thomas W. Evans has been compromised, leaving about $2,000,000 for a Museum and Dental School at Philadelphia.

THE War Department has given orders to have the transport *Hancock* prepared for the use of the new Philippine Commission, which will sail from San Francisco on April 15th. It is of some interest to note that three members of the commission are college professors. Judge Taft, who succeeds President Schurman, of Cornell University, as chairman, is professor and dean in the Law School of the University of Cincinnati.

MR. M. H. SAVILLE, of the American Museum of Natural History, has returned from a very successful trip to Mexico. Archæological explorations at and near the noted ruins of Mitla were prosecuted to such an extent that but little if any archæological work is left to be done there.

SIR WILLIAM MACCORMAC, after having visited Kimberly and Ladysmith in the interest of the sick and wounded, is returning to Great Britain.

MR. W. E. D. SCOTT, curator of the ornithological collections at Princeton University, has sailed for England to study in the British Museum its collections in connection with the monograph he is preparing on the birds brought from Patagonia by Mr. J. B. Hatcher.

MCGILL UNIVERSITY will, on April 30th, confer the degree of LL.D. on Captain Alfred J. Mahon.

THE council of the Iron and Steel Institute, London, has decided to award the Bessemer gold medal to M. Henri de Wendel, of Joeuf, Meurthe-et-Moselle, France. The presentation will take place at the annual meeting to be held in London on May 9th.

THE Smith's Prizes at Cambridge University are awarded to Mr. J. F. Cameron, of Caius College, for an essay 'On molecules considered as electric oscillators,' and to Mr. R. W. H. T. Hudson, of St. John's College, for an essay on 'Ordinary differential equations of the second order and their singular solutions.'

THE Paris Academy of Sciences has elected as corresponding member Dr. Simon Schwendener, professor of botany in the University of Berlin.

The Geographical Society of Paris has awarded its great gold medal to Major Marchand.

THE eminent British meteorologist, Mr. G. J. Symons, F.R.S., died at London on March 10th, at the age of 62 years.

PROFESSOR THOMAS PRESTON, F.R.S., died at Dublin on March 7th, at the age of 40 years. He had been since 1891 professor of natural philosophy in University College, Dublin, and was also science and art inspector for Ireland. He was the author of well-known works on 'Light' and 'Heat.'

ADMIRAL SIR HENRY FAIRFAX, K.C.B., died at Naples on March 20th, at the age of 63 years. Admiral Fairfax had made two voyages to the Arctic regions in the interests of science.

THE deaths are announced of Professor Georg Rümker, director of the Hamburg Observatory, at the age of 68 years, and of Dr. C. T. R. Luther, director of the Düsseldorf Observatory.

MR. ANDREW BOLTER, of Chicago, died on

March 18th, aged 80 years. He possessed one of the finest entomological collections in the United States.

A PRINCETON expedition is busily engaged in preparations for the eclipse of May 28th and will probably leave for Wadesboro', North Carolina, ten or twelve days before the eclipse, that place having been selected, because it is the most easily accessible of the stations where the weather probabilities are equally good. The party will probably consist of Professors Young, Brackett, Magie and Reed, Mr. McClenahan, Mr. Russell and Mr. Fisher, with perhaps one or two others. The work undertaken will be mainly spectroscopic, including particularly a determination, both photographic and visual of the position of the Corona-line. A set of photographs of the Corona will also be taken, and careful visual observations will be made upon the relations between the Corona and the solar provinces.

MR. WILLIAM H. CROCKER has offered to defray the expense of sending a party from the Lick Observatory to observe the total eclipse of the sun on May 28th. The party will be headed by Professors W. W. Campbell and C. D. Perine. A station has not as yet been definitely chosen, but it will probably be at Barnesville near Atlanta.

IT was announced at a meeting of the Royal Scottish Geographical Society, on March 2d, that a Scottish expedition was to be organized to cooperate with the English and German Antarctic expeditions. The Weddell Sea quadrant south of the Atlantic Ocean will be the Scottish sphere. The British sphere will be south of the Pacific and the German south of the Indian Ocean. William S. Bruce will lead the Scottish expedition.

THE appointment of a receiver for the firm of D. Appleton & Co. will be regretted by all men of science. By the publication of the *Popular Science Monthly*, the *International Scientific Series* and many other important scientific works, the firm has done much for the advancement of science.

PROFESSOR PATRICK GEDDES has been making addresses in the United States with a view to arousing interest in the International Association for the Advancement of Science, Arts, and Education, which will hold a first assembly at Paris during the Exposition. We have already called attention to the establishment of the Association which dates from the recent meeting of the British and French Associations at Dover and Bologne. M. Bourgeois is general president of the Association, and the vice-presidents of the French group are M. Gréard, rector of the University of Paris and M. Brouardel, last year president of the French Association. The vice-presidents of the English group are Dr. James Bryce and Sir Archibald Geikie. The secretary is Professor Patrick Geddes. The object of the assembly at Paris appears to be chiefly social and a guide to the Paris Exposition and its congresses. Headquarters will be established and information by lectures and otherwise in regard to the congresses, the exposition and the educational advantages of Paris will be provided. The membership fee is $5.00.

A JOINT resolution has been introduced in Congress authorizing the publication of fifteen thousand copies of the general report of the expedition of the steamer *Fishhawk* to Puerto Rico, including the chapter relating to the fish and fisheries of Puerto Rico, as contained in the 'Fish Commission Bulletin' for 1900; nine thousand for the use of the House, three thousand for the use of the Senate, and three thousand for the use of the United States Fish Commission.

GOVERNOR ROOSEVELT of New York and Governor Vorhees of New Jersey have signed bills providing for the appointment of commissions to protect the Palisades. The commissions have power to condemn land containing the steep rocks, but it does not appear that New Jersey has made any appropriation for the purchase of the land.

BARON VON LIPPERHEIDE has presented to the Prussian State his collection of works on costume. It contains over 10,000 volumes and about 20,000 separate plates, being the most complete collection in the world. The history of industries, etc., are in large measure represented and the collection is thus of considerable anthropological interest.

ANOTHER attempt to create an artificial uni-

versal language has been published by Dr. Ad. Nicolas of La Bour boule, in the Memoirs of the National Society of Agriculture of Angers. This newest language is called *Spokil*. The author's object is to "combiner l'euphoine, la mnemotechnie, l'analogie, l'étymologie, l'idéographie." The following are eight consecutive roots: "Eibo, pocher; Eigm, mucilages, Eign, charbon; Eivl, bourre; Eivr, filament; Eipl, elements ligneux; Eipn, gaz; Eikl, percuteurs." It seems unlikely that 'Spokil' will attain even the temporary vogue of Volapük.

A WEEKLY botanical convention of the botanical workers in New York City, is held at the Museum of the Botanical Garden, on Wednesday afternoons, which is open to all interested persons. Among the subjects which have been presented the following are to be noted: Dwarfs and Nanism in general, by Dr. MacDougal, with an exhibition of dwarf Japanese trees, by Mr. Henshaw; Plants and poisons, by Dr. R. H. True; Spore dissemination in the Sordariaceæ, by Mr. David Griffiths; the Flora of Montana and the Yellowstone Park, by Dr. Rydberg, with an exhibition of new and interesting species from the regions named; and the origin of the leafy sporophyte, by Dr. C. C. Curtis.

IN view of the U. S. Treasury decision relative to free importation of philosophical apparatus and preparations, which is likely to affect seriously the work of educational institutions and the laboratories of research, the Council of the American Chemical Society has voted that the president of the Society be authorized and directed to appoint a committee consisting of fifteen members of the Society, who shall be instructed to consider the present status of the laws and regulations governing the free importation of instruments, apparatus and materials used in research work, and to take such action in the premises in the direction of securing such new legislation or modifications of existing laws and regulations as they may find necessary to the interests of the educational and research institutions.

Nature states that letters have been received from Mr. J. E. S. Moore's expedition dated from Ujiji, on Lake Tanganyika, November 12, 1899. The other members of the party had proceeded to the north end of the lake, where Mr. Moore was proposing to join them so soon as the necessary number of porters had been assembled. The expedition had been fairly successful both in collecting zoological specimens from the lake and in studying the geological features of the surrounding district. They had obtained numerous living specimens of the curious forms of mollusca of the lake, besides a good series of fishes and crustaceans. The celebrated jelly-fish (*Limnocnida tanganjicae*) had been met with in great numbers. Mr. Moore had escaped fever altogether, but most of the other members of the party had had a touch of it.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. J. D. ROCKEFELLER has offered to give $100,000 to Wellesley College on condition that the debt of the college of about the same amount be paid by subscription from the alumni.

THE Tulane University of Louisiana has received a gift of $50,000 from Mrs. Caroline Tilton to assist in establishing a library in honor of her husband.

THE foundations for a chemical laboratory at Oberlin College have recently been laid. The chemical laboratory at Hobart College is to be enlarged and one of the dormitories will be fitted up for the work in physics, biology and geology.

DR. J. N. LANGLEY will be deputy professor of physiology at Cambridge University for Sir Michael Foster, M.P.

MR. J. H. JEANS of Trinity College, Cambridge, has been elected to the Isaac Newton Studentship in astronomy and physical optics.

MR. H. WOODS, M.A., of St. John's College, has been appointed University lecturer in paleozoology for five years from Michaelmas, 1899.

DR. DRUDE, associate professor of physics at Leipzig, has been called to a full professorship at Giessen.

DR. KÖNIGSBERGER has become docent in physics at Heidelberg; Dr. F. Streintz in electro-chemistry at Göttingen, and Dr. Richard Meyer in chemistry at Berlin.